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# AN AGRICULTURAL SURVEY OF THE MARKHAM VALLEY IN THE MOROBE DISTRICT.

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This tract of country presents most interesting features, and it merits a detailed description as it appears from many points of view to be one of the most promising in the Territory of New Guinea (together with the Ramu and Purari Valleys) for the grazing of cattle, and the possible development of native agriculture under administrative supervision.

## Topographical Features.

### A.—Mountain Ranges.

The River Markham flows into the head of the Huon Gulf. Viewed from the sea its valley appears as a broad cleft dividing the high mountain ranges of the Huon Peninsula from the equally high mountain ranges of the mainland.

The valley runs in a north-westerly direction from the mouth of the river. At its headwaters, at an elevation of 1,350 feet, the river is separated from the Ramu basin by a grassy plain, the actual divide being almost imperceptible. The Ramu basin continues on from this point also in a north-westerly direction until the Ramu River enters the sea near the mouth of the Sepik River on the northern coast of New Guinea. The remarkable similarity in type and in direction of the two valleys, points to a common geological origin.

The valley of the Markham about half-way up, changes its direction abruptly through an angle of a few degrees, and in its upper portion runs in a more northerly direction than the lower portion. On the eastern flank of the valley at this point there is a low range of hills with a strikingly regular saw-edge summit—sierras on a small scale.

The Markham basin is bounded on the east by the high mountains of the Huon Peninsula including the Finisterre, Cromwell, Saruwaged and Rawlinson Ranges, and on the west by the Kratke, Kuper and Hersog (Buangs) Ranges. The influence on the climate of the valleys of these large mountain masses on either flank is important, and will be referred to later under "climate".

### B.—Rivers.

The River Markham is approximately 95 miles in length, and flows in a general south-easterly direction into the Huon Gulf. Its course follows along on the extreme western edge of the valley bottom, practically hugging the foothills. The plains, therefore, are on the eastern side of the river, and are drained by tributary streams from the mountains on that side. They are all surface streams, some without any clearly defined watercourse, and these are apt to change their course within the limits of a wide bed. The whole width of channel of every stream is covered with water-worn pebbles. None of these rivers has a muddy bottom, and if transport vehicles come to the valley, no difficulty should be experienced in crossing. Normally the streams have little or no water except in the case of the River Leron. They rise and fall quickly, and are in fact, merely flood channels which carry off storm waters after downpours in the mountains. Except in the case of the western bank of the Leron River which is about 20 feet high, the stream bed in every case is level with, or within a few feet of, the level of the plain.

The following is a list of the tributary streams in order of position beginning at the mouth of the Markham River, with a few notes on each as supplied by G. Bryce, D.Sc. (Edin.), late Director of Agriculture, Rabaul, in a report compiled in 1925:—

R. Munum—at 15 miles from Lae. Width of bed 20 yards. Gravel bottom. Water running only in small shallow channel. Bed level with plain.

R. Ilap—at 28 miles from Lae. Bed ½ mile across. Pebbly bottom. Water running in two channels each 20 yards across and 2 feet deep. Bed level with plain.

R. Mararomi—at 32 miles from Lae. Bed 30 yards across. Pebbly bottom. Water running in channel 2 yards across, and 2 inches deep. Bed level with plain.

R. Narawantopa—at 33 miles from Lae. Bed 10 yards across. Gravel bottom. Only a trickle of water running, stream probably usually dry. Banks 3 to 4 feet high.

R. Shangat—at 34 miles from Lae. Bed 20 yards across. Gravel bottom. Only a trickle of water running, stream probably usually dry. Banks 6 feet high.

R. Wowin—at 38 miles from Lae. Bed 7 yards across. Gravel bottom. Shallow stream occupying whole bed, probably permanent. Bank 4 feet high.

R. Romu—at 40 miles from Lae. Bed about 1½ miles across. Gravel bottom. Water running, in three channels respectively 20 feet across, 3 feet deep, 8 feet across shallow, and in third channel three small streams each 8 feet across and shallow. Bed level with plain.

R. Safeh—at 43 miles from Lae. Bed 20 yards across. Gravel bottom and dry. Banks 12 feet high. A second channel occurs ¼ mile to the west. Bed 60 yards across, gravel bottom. Stream 8 feet across and shallow. Banks 3 feet high.

R. Leron—at 50 miles from Lae. Bed about ½ mile across with pebbly bottom. Three streams each 10 to 15 feet across and 1 to 2 feet deep. Main stream 25 yards at crossing, and 3 feet deep, flowing about 8 miles per hour. East bank level with plain. West bank 18 feet high. Stream bed 4 yards across with sandy bottom. Stream 20 feet across, 3 feet deep. Banks 3 feet high.

R. Iroap—at 56 miles from Lae. Bed 20 yards across with gravel bottom. Stream 20 feet across and 2 feet deep, banks 3 feet high.

R. Manyang—at 66 miles from Lae. Bed 2½ miles across with gravel bottom. Bed level with plain. Four main channels respectively 150 yards across, 100 yards across, 50 yards across, and 200 yards across, each with an insignificant flow of water.

R. Oroboar—at 68 miles from Lae. Bed 30 yards across with gravel bottom. Stream 20 feet across, shallow. Bed level with plain.

R. Markham—Markham crossing at 70 miles from Lae. The bed at the crossing from the Atzera to the Amari district is about 600 yards across with a pebbly bottom. There are three channels, but only one contained water, and this was about 30 yards across, 3½ feet deep with a flow of 8 miles per hour; the stretch from Gabsonket to the sea, down which we travelled by raft, is about 20 miles in length. The breadth of the bed is about ¼ mile, the stream is much broken up into channels by sand and gravel, with banks of considerable size. The channels vary in depth, generally only one channel being navigable by canoes or rafts It is unlikely, therefore that it will prove of any great use for transport.

Note.—The Rivers Ilap, Romu, Manyang which are described as having beds of 1 or 2 miles across are in reality surface streams, flowing only after rain in the hills. The whole width is unbroken, the bed being frequently split up by banks of varying depths covered with grass. These rivers, obviously, change their channels frequently within the limits of the bed as indicated by Dr. Bryce, and it probably gives a truer appreciation of the circumstances to set down, as he has done, the whole width of country over which they flow at one time or another. They present no difficulty to wheeled transport, save that of loose gravelly surface and an occasional flood.

## C.—Plains.

The Markham Valley from the sea to its headwaters forms one plain with a gradual rise in elevation. The elevations noted on this inspection are—

Lae—sea level.
River Wowin—480 feet.
River Leron—600 feet.
River Markham crossing—1,250 feet.

Laterally the valley is level throughout its course, and the valley floor may be represented diagrammatically as an inclined plane rising from the sea level. There are, of course, fluctuations in level, notably slightly undulating country west of the River Wowin, but these are inconsiderable, and the diagrammatic representation may be taken as true for all practical purposes.

With such conditions as to level, it is to be expected that the plain would be well drained, and this is the case. There is an almost complete absence of swampy land, such infrequent marshes that occur being small in size. The largest marsh seen is 6 miles east of the Leron River, and measures approximately ½ mile in diameter.

As the valley floor is level across its width, the foothills on each side appear to arise abruptly from it, though the actual angle of their slope is not great.

The Markham plains are a remarkable feature in a mountainous country like New Guinea, and indeed, considered in conjunction with the topography of the district, they would be remarkable anywhere.

Between the Rivers Ilap and Iroap—a distance of 30 miles—the valley is, on the average, 12 miles wide, and in the vicinity of the River Leron—where there are no trees—the whole sweep of the valley with the mountains towering in the distance lies before the eye.

Similar wide views may be obtained in other parts of the valley, but the presence of trees reduces the area visible at any one time.

The estimated area of the plains of the valley as shown, may be taken conservatively—

| | | |
|---|---|---|
| Gabsonket to the River Wowin | .. | 378 square miles |
| River Wowin to River Leron .. | .. | 243 ,, ,, |
| River Leron to River Iroap .. | .. | 97 ,, ,, |
| River Iroap to River Markham | .. | 110 ,, ,, |
| River Markham to the valley-head | .. | 100 ,, ,, |
| River Watut Valley .. .. | .. | 120 ,, ,, |
| Total .. .. .. | .. | 1,048 ,, ,, |

The forest area at the river mouth is not included here, and it must be remembered that the River Watut comes in on the west side of the Markham River.

To obtain the cultivable position there requires to be deducted the areas of river beds from which the soil has been denuded. The areas occupied by the above rivers are estimated as under—

| | | |
|---|---|---|
| River Markham .. ... | .. | 95 square miles |
| River Ilap .. .. .. | .. | 27 ,, ,, |
| River Romu .. .. .. | .. | 27 ,, ,, |
| River Leron .. .. .. | .. | 36 ,, ,, |
| River Manyang .. .. | .. | 20 ,, ,, |
| River Watut .. .. .. | .. | 20 ,, ,, |
| Others streams, say .. .. | .. | 100 ,, ,, |
| Total .. .. .. | .. | 325 ,, ,, |

The total area of cultivable land is, therefore—

1,048 less 325 equals 723 square miles or approximately 450,000 acres.

## D.—Geological Features.

It has been suggested elsewhere from time to time, that the valleys of the Markham and the Ramu owe their origin to a great fault or rift in the terrain, although, incidentally, this fault has been utilized by both rivers as a convenient means of access to the sea.

The valley is bounded on either side by high mountain ranges which reach an altitude of 12,000 to 13,000 feet, and exercise a profound influence on the climate of the valley plains below.

The sierra in the Leron region is composed of conglomerates, soft friable sandstone and mudstones with fossil shells. Many water-worn pebbles of these rocks were seen in the bed of the Leron. These sedimentary rocks probably continue down the valley towards the coast, though they do not form in other places this remarkable saw-edge summit. In the stream flowing through the forest region near the mouth of the Markham River brown coal has been picked up. The deposit has been known for some considerable time. This deposit probably comes from the same geological formation as that of the sierra.

The rocks forming the high mountains behind the sierra and on the Huon Peninsula are apparently mainly diorites, as the greater portion of the large pebbles in the river-beds is derived from this rock.

No metamorphic rock specimens were seen. On the western side of the valley outcrops of crystalline limestone occur.

The geological history of the region in recent times gives the impression that the Huon Peninsula was an island, and at this stage the corals were formed. As the land rose the sandstones and conglomerates of the sierra of the Leron region were deposited, and at the same time the fine loam of the valley bottom was laid down. Subsequent uplift must have been rapid as the valley still presents these features in its present condition. It seems probable that the soil of the valley was laid down under estuarine conditions, and the presence of brown coal near the mouth of the valley tends to support this theory. It does not seem to be possible otherwise to explain the great depths of fine loam that are to be seen in the river-bank sections, where the surface loam is found unchanged at depths of 20 feet or so, below soil level. Many profiles were examined over various parts of the valley, and in no instance was the transition from soil to sub-soil in any such sections observed.

## E.—Soil.

The soil of the valley is one of its most outstanding features. In view of the type of soil deposition it would be natural to expect the valley to be extremely fertile, but actually the fertility is anything but consistent throughout. The so-called Markham Valley is really a rift, and the whole country is geologically very new, and shows evident signs of recent uplift.

The Markham and its tributaries have not yet had time to carve out beds for themselves, and at present they are shallow and turbulent streams flooding over the surrounding surface. In some cases they have actually built up a bed for themselves that is higher than the level of the surrounding country. The current is in all cases very swift.

Considering the moderate volume of water these rivers usually carry, their beds cover a very wide area since they frequently change their courses. The Manyang River, for instance, has a course which is 3 miles wide, and flows in two or three channels. It brings down large quantities of stones, gravel, and coarse sand, and frequently bursts its banks, tearing out fresh channels, and depositing large quantities of rubbish, thereby ruining much good agricultural land. The Ramu is another example, but in this case the stream passes through foothills of sandstone, and consequently alluvial deposits of sandy loam are beginning to form in the lower reaches of its course.

The Markham itself is so swift flowing, and has such a steep bed, that it has not yet had time to deposit much alluvium on its banks, and its flood plains are consequently covered with stones and layers of coarse gravel.

To the casual observer the vast plains of waving grasses will convey an impression of luxuriance and deep fertile soils, but the hasty survey the patrol was able to make showed that this was not the case.

Large areas of fertile soils do occur, but equally large areas consist of shallow stony soils, which would probably not be worth cultivating, although they should eventually prove to be of considerable value for pastoral purposes.

The land on both sides of the Leron River several miles in width, consists of gravel patches covered with a thin layer of soil varying from 3 inches to 1 foot in depth.

Away from the river banks the soil often improves, but generally speaking the extent of good soil is larger between the Wowin and the Ilap rivers than it is between the Wowin and the Leron. However, about a mile north of the Wowin River, a stretch of exceptionally fertile soil occurs which appears to have been an old lake-bed several square miles in extent.

The soils in the valley are generally black, chocolate or grey coloured medium loams with good sub-soil drainage, towards the headwaters of the Markham River. Large areas of this type of land with a foot to 18 inches of soil may be worth experimentation with shallow rooting crops, more especially as they are not deep enough for bananas, taro, yams and other root crops, and so are not likely to interfere with the native food supply.

The deep heavy soils are usually denoted by a heavy growth of Kunai or "blady" grass (*Imperata arundinacea*), heavy swamps carrying cane-grass (*Saccharam spontaneum*) and a reed.

Soils of medium depth carry a heavy growth of Kunai mixed with a large kangaroo-grass (*Themeda gigantea* or *Anthistera sp.*).

Shallow stony soils carry sparse short kangaroo-grass probably *Themeda elatior*, and a smaller annual species.

The incidence and growth of the above grasses afford a very good guide to the character of the soil in the valley.

Sufficient was seen to indicate that when this valley is opened up and land settlement is undertaken, as presumably will be the case, one of the first things to be done will be to make a careful soil survey of the whole area, since the character of the soil varies greatly and within short distances.

## F.—The Climate.

No accurate information of the rainfall, temperature, and humidity are available since it is only recently that this area has really come under control. There seems to be no doubt, however, that the lower part of the valley has a different season from the middle and upper portions.

However, an average rainfall of 100 inches per annum was recorded over a period of five years at Kaiapit (approximately 70 miles from Lae) by the Lutheran Missionary stationed there, whilst at Sangan Experimental Station in 1926, about 55 miles from Lae, and in the centre of the valley, an average rainfall of 70 inches was recorded. In both cases practically the entire rainfall was recorded during the north-west season.

The average annual shade temperature noted was 86 degrees.

The dense heavy rain-forest around Lae and for about 28 miles inland has a much greater rainfall than the upper reaches of the Leron River during the south-east season, i.e., from June to October.

The dividing line between the two regions is somewhere about the line of the Ilap River, which is 4 miles beyond Gabsonket village, and about 28 miles from the sea. From here up the valley there are signs of a much drier climate, and it is believed that the majority of the rain falls during the north-west season, November to May. There is no record of the total annual rainfall, but it is obviously very much less than lower down the valley or in the ranges that bound the valley on either side.

One peculiar feature of the climate is the prevalence of winds. The occurrence of high winds from the north-west at certain seasons has been remarked by the Reverend Oertel, Lutheran Missionary at Kaiapit, and likewise the prevalence of winds from the opposite direction during the south-east season. This was particularly the case in the treeless region in the neighbourhood of the Leron and Wowin rivers.

Two other climatic factors are worthy of mention. They are atmospheric humidity, and the prevalence of cloud and of early morning mists, as in the Wampit and Bulolo valleys.

The two main climatic seasons in this territory are controlled by the north-west (monsoonal), and the south-east winds respectively.

The north-west period is generally regarded as the wet season, but there are places in the territory where the position is reversed. The coastline fronting the Huon Gulf from the mouth of the Markham River to Cape Fortification enjoys a dry spell in the north-west monsoonal period, and gets all its rain in the south-east season.

Prevailing winds are the decisive factor, governed by the coast and inland mountain ranges, for the annual rain period, and for this reason, contrasting conditions appear at small distances apart. Thus as might be expected over such large land areas as are found in this valley, the climatic conditions vary considerably.

During the north-west monsoonal period, although the Huon Gulf country is undergoing a dry spell, the inland mountain ranges are being subjected to continual heavy rains, and it is during this season that the Markham River becomes a raging torrent, overflowing its banks for many miles, and inundating low-lying country for weeks at a time.

### G.—Botanical Features in the Valley.

Although no definite data is available as to the origin of this grassland, the presence of old devoru (*Alstonia scholaris*) and other trees are proof that the land was once covered with intermediate forest, and that the present growth has been artificially caused by the shifting agricultural methods as practised by natives in the past.

Grass cannot ordinarily compete with weed-trees, and were it not for the annual burn-off, to which this valley is regularly subjected, it would not be so very long before the valley would be converted back from grassland to secondary forest.

Unfortunately, the native pursues only one system of agriculture throughout the whole Territory of New Guinea as he has not yet learned the use of modern implements and methods. This system comprises the cutting down of bush, burning it off, and the planting of tuber crops. When the ground is thoroughly worked out grass and weeds and small trees take hold, but before the latter can become permanently established, fires are lit by the natives in the dry season to drive out the bush rat, pig and wallaby, which are hunted for food. Thus the natives have come to rely upon these annual burnings as one source of food supply. Were the native to forego burning the grasslands for a few years, the weed-trees (low secondary bush) would doubtless re-establish climatic conditions and environment; woodlands have a decided advantage over grasslands.

Throughout the whole of the areas examined weed-trees were seen struggling for existence, and of the many varieties observed, the extraordinary predominance of *Albizzia procera* in the drier, and *Sarcocephalus* (*Nauclea*) in the wetter areas were noted species. Here and there in the valley, but more particularly east of Chivasing village, thick barked *Clerodendrons* flourish despite fire, whilst *Erythrina* thrives along the higher banks of watercourses.

Grasslands occur sporadically between Kaiapit and Sangan, but it is only after leaving Sangan that the first of the large areas of grasslands occurs. Between the villages of Chivasing and Sangan lies a considerable flat stretch of country comprising the cleanest stand of pure grass in the valley. This stretch is broken by the Leron River and its confluents, which are timbered along the banks, but apart from these, the land is free from tree growth.

Along the foothills of the mountains to the north and stretching down into the plain for perhaps 2 miles, a cycad (*Cycas media*) is to be found, and this gymnosperm is so numerous as to give character to the landscape. The area of this stretch of country would be about 60 square miles, and in this area there are no pure stands of kunai grass (*Imperata arundinacea*) to be seen.

The flora on this portion of the valley contains an admixture of grasses, the main two being "kunai" (*Imperata arundinacea*), and a species of "kangaroo" grass (*Themeda* or *Anthisteria sp.*). The proportion of the two grasses would be approximately 25 per cent. kunai to 75 per cent. kangaroo.

In addition to these two grasses many more were seen, including a species *Saccharum spontaneum*, which occurs in damper lands, and a wild sugar-cane *Saccharum robustum* predominates along the low-lying stony river flats where the land is subject to flooding. *Saccharum spontaneum* grows profusely, and takes up all the marshy land, and in March and April the banks of the Markham, and most low-lying land in the valley are white with tasselled tops of this species. This grass is closely related to the Pollinia grasses of which possibly many more occur than were seen, owing to the nature of the country and the limited time available for inspection.

On the better quality and deeper alluvium, kunai grass takes a firm hold, but on the poorer stony soils such as those found on the slopes of the valley, kunai grass is gradually replaced by kangaroo grass, and as one ascends higher the kunai is completely eradicated by this species.

This grass extends into the hills on either side of the valley, and, aided annually by the natives' hunting fires and clearing operations, has reached an elevation of approximately 3,000 feet in places. Thus, with the help of this kangaroo grass, the savannah of the Markham Valley has extended up into the mid-mountain forests. Two varieties of this grass were seen, and have since been identified as *Themeda gigantea* and *Themeda amboinensis*.

On leaving this area and proceeding out into the valley towards the Markham River about 50 miles from the coast, we find that the admixture of kunai and kangaroo grass is gradually replaced by *Saccharum spontaneum* (wild cane of Asia), and the dense matted rhizomes of these two main grass species form those grasslands which prevent the establishment of the rain-forest timber species.

These grasslands are not natural xerophilous regions, but are converted rain-forests, whilst on the less fertile land secondary weed-tree growth has established itself. Thus throughout the valley there are large areas of grasslands dotted with trees which, from a distance, give the appearance of natural savannah forest.

That cultivation began and hunting fires finished the conversion of this area is evidenced by the presence of significant devoru (*Alstonia scholaris*) and various living trees on all parts of the valley. Thus on land which has evidently been farmed continuously for many years we find *Macaranga spp.* cropping up, and to a lesser extent *Kleinhovia hospita, Alstonia longissima* and *Ginginsia pruinosa.*

Originally the gully forests were made up of hygrophyllous trees, but now only fire-resisting species such as Clerodendrons can establish themselves in open forest formation.

*Albizzia* sp. are treelets which spring up all through these grasslands, Chivasing and Wowin, and as previously stated, are present in extraordinary quantities. These are not large trees, and with the exception of *Albizzia alba,* which yields a valuable hard wood that is white ant resisting, the wood is of no consequence. They are a savannah forest type, and become leafless in the dry season when they also seed prolifically.

Various varieties of *Albizzia* were noticed throughout the valley of which possibly the commonest is *Albizzia moluccana,* and *Albizzia alba,* but perhaps the most predominant variety is *Albizzia procera* which occurs on the moister lands, and all grow as well here as in the rain-forest.

Two other varieties of trees which are worth mentioning were noticed in the valley. They have no known commercial value, and are only mentioned because of their recurrence throughout the valley.

The first *Rhus simarubaefolia* occurs in wooded gullies or edaphic regions of the grassy hills in the valley, and the second, known as *Diplanthera tetraphylla* is to be found in grass patches up the slopes of the valley between 1,000 and 2,000 feet.

Many other varieties of trees were seen along the edges of the valley, and these will be mentioned later.

Prior to enumerating the various Gramineae found in the valley it is necessary to indicate this important fact, that, apart from several small isolated stands of pure kunai of only a few hundred acres in extent, it was found that the Markham Valley is covered with a very mixed stand of grasses, the predominant species in their order of importance being—

*Imperata arundinacea (Imperata cylindrica).*
*Themeda gigantea.*
*Saccharum spontaneum.*
*Imperata exaltata.*
*Eragrostis* vars.
*Paspalum* vars.
*Polliniae* spp.

On the poorer types of soil bordering the upper reaches of all rivers or confluents, and on all grass-covered hills, *Anthistiria gigantea* predominates, completely eradicating kunai grass.

On higher land a species of the sub-family *Andropogoneae*, identified as *Andropogon serratus*, is to be seen, and to a less extent *Cymbopogon nardus var-Flexuosus*, and it is quite possible that many more varieties of *Andropogoneae* thrive in these regions than were observed.

In addition to *Imperata arundinacea* (kunai) in the valley, another grass was noticed occurring with it, but more particularly in the moister areas, which very closely resembles kunai grass, and this is probably a variety known as *Imperata exaltata*.

Other *Gramineae* identified were *Coix lachyrma-jobi* (a native of India) which was found in waste areas; *Eragrostis elongata* and *Chrysopogon aciculatus* (Love grasses); *Eleusine indica* (finger grass) was also noticed on wet, moist places; *Manisuris granularis* was seen vieing with kunai in places, and another variety known as *Manisuria cylindrica* found growing on marshy areas. Pigeon grasses *Setaria aurea* and *Setaria glauca* (based on *Panicum glaucum var. elongatum*) occur all through the valley as do Panic and Paspalum grasses of which the most common is *Panicum pilipes, Panicum distachyum, Paspalum conjugatum* and *Paspalum longifolium*. Both these grass types occur on open plain country. Two other grasses identified as *Polytoca macrophylla* and *Apluda mutica* were noticed frequently amongst the taller perennial grasses, and to a lesser extent *Pogonatherum crinitum*.

A good fodder grass known as *Pennisetum marcostachyum*—closely resembling the well-known *Pennisetum ruppellii*—occurs, together with *Sorghum plumosum*. This latter is a wild sorghum found in most tropical countries, and often referred to as *Andropogon australis*.

Several *Ischaemum* grasses were seen to be thriving well in thickets bordering low-lying wet lands, the only one identified being *Ischaemum muticum*; but possibly varieties such as *Ischaemum intermedium* and *Ischaemum turneri* also are to be found, as conditions are similar here to other localities in the territory where these varieties are known to exist.

The mountains south of the Markham River and running parallel to it are clothed in forests, into which in some cases, as previously stated, grass has forced its way; but the mountains along the northern boundary of the valley are almost entirely clothed in artificial grassland. On the north-east corner of the valley, however, a lot of natural forest still remains, and here an indication as to the nature of the tree growth was obtained.

In flying over this country it is most startling to see such a large sea of grassland country lying adjacent to a typical rain-forest, in some cases completely surrounding it, whilst on the slopes of the valley at no greater height than 2,000 to 3,000 feet, areas of the conifer known as Hoop Pine, *Araucaria klinkii*, are to be seen growing alongside *Sarcocephalus* species.

On the lower slopes the following species were seen:—

*Afzelia bijuga (Intsia bijuga)*.
*Gnetum gnemon*.
*Pometia pinnata*.
*Breynia cernua*.
*Albizzia moluccana* and *Albizzia alba*.
$\left.\begin{array}{l}\textit{Chisochaeton biroi}\\ \textit{Dysoxylum}\text{ spp.}\\ \textit{Baccaurea}\text{ spp.}\end{array}\right\}$ affinities.

In addition to these, other trees forming the rain-forest belt on lower-lying country are enumerated as under:—

*Celtis philippensis.*
*Pterocymbium* spp.
*Octomeles sumatrana.*
*Bombax malabaricum.*
*Vitex cofassus.*
*Morinda citrifolia.*
*Chrysophyllum roxburghii.*
*Planchonia timorensis.*
*Alstonia scholaris.*

Of the above there appears to be a predominance of *Celtis philippensis.*

Several herbs occur amongst the grass, the more common being *Osbeckia chinensis* and *Exacum tetragonum*, whilst another small plant known as *Bola (Baca) lanuginosa* was noticed in abundant quantities in the grass hills. *Urena lobata,* a mallow, was also seen in the valley but not in large quantities.

Many years ago the Administration commenced a roadway from Lae to Gabsonket village, but this scheme was abandoned in favour of aerial transport, and at the present time this road is impassable for traffic; indeed it is with the greatest difficulty that one is able to traverse the road on foot.

The usual method of transport down the Markham River is by raft, for owing to the swiftly flowing nature of the Markham, and its many confluents—which are of an extremely shallow nature, and contain snags and debris in great quantity—boats or canoes are impracticable.

The favoured method of transport to-day is by aeroplane, as there are many aerodromes and emergency landing grounds situated throughout the valley. The same may also be said for the Ramu Valley.

Should a time come when these valleys are occupied and cultivated by settlers, it will be necessary to re-open the road from Lae which was originally commenced by the Department of Agriculture, in 1926, as a means of communication to the "Cotton Experimental Station" situated at Sangan.

In conclusion, it may be stated that the Markham and Ramu valleys have a healthy climate suitable for white settlers, a soil of great potential fertility, and a climate suitable for the grazing and fattening of cattle.

ACKNOWLEDGMENT.

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# BIOLOGICAL CONTROL OF INSECTS.

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One commonly hears allusion made to the phenomenon known as the "Balance of nature", the principle on which are based all attempts at biological control, that is, the control of one species of living thing by another. The phrase "Balance of nature" describes the state of equilibrium which occurs in any given locality between the native species of plants and animals. Any one species is prevented from multiplying to such an extent that it will jeopardize the welfare of the others, and each component of the native fauna and flora takes its part in confining the other components to a limited sphere. The principle is well illustrated by the predatory animals which keep down the numbers of other wild life.

Man, however, in his agricultural activities, interferes with natural conditions, and provides large areas of succulent food, on which various species of native insects thrive. Moreover, he frequently introduces, usually by accident, new kinds of insects from distant localities, often without the parasites which preyed upon them in their natural habitat. Hence the newly introduced insect, free from attack by its natural enemies, spreads with a rapidity which threatens serious damage to crops and stock, and it then has to be controlled artificially or biologically. Biological control consists of finding parasites of the injurious insect in the locality from which it was brought, and introducing them into the new area in the hope that they will adapt themselves to the new environment and reduce the numbers of the pest below the danger level. Obviously this method of controlling insects is ideal, for, once established, the parasite costs nothing, and in successful cases it keeps its host down to negligible proportions. But first the parasite must be found, and later successfully introduced into its new environment. The rewards of victory are so great, however, that many countries keep permanent staffs working on parasite introduction alone, the United States of America in particular spending huge sums on this work.

Though parasitism of insects by other insects has been known to observers since the beginning of the seventeenth century, it was not until 1889 that the first really great success was achieved by biological control methods. It was in this year that Koebele imported into California from Australia the lady-bird beetle *Vedalia cardinalis,* and thus saved the Californian citrus industry from the ruin which threatened it as a result of the ravages of the Cottony-Cushion Scale, *Icerya purchasi.* The story of this accomplishment, the first great landmark in the history of the biological control of insects, has often been told, but nevertheless it cannot be omitted from any discussion of the subject.

The Cottony-Cushion Scale had become firmly established in the citrus groves of California, and was the cause of immense loss to the growers, owing to the cost of controlling it by artificial methods. Riley, who was in charge of the entomological work of the United States Department of Agriculture, knew that the insect had been introduced from Australia or New Zealand, and by corresponding with entomologists in those two countries, he found that while the pest was abundant and injurious in New Zealand, it was not considered a pest in Australia. From these facts he concluded that Australia was the home of the insect, and that it was held in check there by natural enemies. In 1887, specimens of a parasite were sent to him from Australia, proving to be a remarkable new species of fly now known as *Cryptochaetum iceryae.* Riley was now eager to go to Australia to obtain supplies of this parasite, but was unable to do so. It happened, however, that in the following year an international exposition was to be held in Melbourne, and the United States of America intended sending a party of representatives. Riley arranged for one of his assistants, Albert Koebele, to be included in the party for the purpose of collecting parasites of the Cottony-Cushion Scale.

On his arrival in Australia, Koebele collected and sent back material containing *Cryptochaetum,* which, however, did not prove a success; but he found *Vedalia cardinalis,* the lady-bird beetle, feeding on the scale, and forwarded several colonies to Los Angeles, comprising 139 beetles in all. A few months later, the lady-birds were liberated in the field, and within twelve months the Cottony-Cushion Scale was practically wiped out in California. The growers and many of the leading men in the horticultural industry were wildly enthusiastic over this spectacular success, and were convinced that at last the panacea had been found for the control of all insect pests. As a matter of fact, Dr. Howard, of the United States of America Department of Agriculture, states that this achievement was by no means an unmixed blessing, as it set back control work against insects for many years, due to a lack of faith in artificial methods of control. *Vedalia cardinalis* was subsequently sent to many parts of the world where the scale was a pest, and everywhere it registered a complete and rapid victory.

The investigation of the reasons for the great success of *Vedalia cardinalis* is of particular importance to the student of biological control, as it sheds considerable light on the question of the qualities in a parasite or predator which should be looked for as desirable. The main factors in the success of the lady-bird may be tabulated as follows:—

1. It is largely independent of climatic conditions, flourishing in almost every locality where its host is found.

2. It is a "specific predator", that is its activities are confined to one insect species, instead of being dissipated on a number, and it devours large numbers of its host in all stages of its (the parasite's) life-history. (An insect which devours its host is usually referred to as a predator, the term "parasite" being commonly restricted to internal parasites, which develop within the body of their host. Predators usually are not specific, this characteristic being more often found among internal parasites.)

3. It is very active, and spreads rapidly, while its host is sedentary.

4. It has approximately three generations to the scale's one.

5. It is exceptionally free from natural enemies.

A great deal of work has also been carried out in California on the Black Scale, *Saissetia oleae.* Several parasites of this insect have been introduced, and the best of them is *Metaphycus lounsburyi,* brought from Australia in 1916. It is, however, by no means as effective as it should be, because it is attacked by a secondary parasite, *Quaylea whittieri,* which was introduced from Australia in 1901, and liberated under the mistaken idea that it was a parasite of the scale. It lived on another parasite of the scale until the introduction of *Metaphycus,* which was its preferred host, and to which it has now transferred the bulk of its attention.

The introduction of secondary parasites is a danger which nowadays is carefully guarded against by entomologists who attempt to import parasites, for once they are established in the field, they cannot be got rid of, and may cause, as in California, the annual loss of thousands of pounds. Two precautionary measures which definitely establish whether a parasite is primary or secondary are first the examination of the parasitized material from which the insect has emerged, to see if there are any remains of the larvae or pupae of primary parasites, and second a trial of whether the suspected parasite will breed in unparasitized specimens of the host insect. For instance, before *Dorinia leefmansi,* a primary parasite of *Sexava* eggs, was transferred from Lavongai to Manus, these tests were applied, revealing the fact that *D. leefmansi* was a primary parasite. Similar precautions were taken with *Leefmansia* before its introduction from Amboina as a parasite of *Sexava* eggs.

One of the most interesting phenomena met with in biological control work on insects is "multiple parasitism", that is, a simultaneous attack on a host insect by two or more species of parasites. The practical considerations arising out of this phenomenon are among the most important in the whole field of biological control, because they affect in the most decided fashion the policy to be pursued in the introduction of parasitic insects. Entomologists who have studied the subject have held radically different views on the question of whether it is better to introduce only one parasite of any given stage of an insect's life-history, choosing, of course, the most efficient, or to bring in as many different species of parasites as are available.

The point at issue is that if one parasite attacks say 80 per cent. of the hosts in its natural habitat, and the other only 40 per cent., would it not be better to introduce only the former, as it is the more efficient, rather than have the two competing with one another, possibly to the detriment of the better parasite. It oftens happens, too, that when two such parasites have both attacked the same host, the less efficient one proves more hardy, and survives while the other perishes. This subject has been extensively studied by Willard and Pemberton working on parasites of fruit fly in Hawaii. Several species of parasites have been introduced, and Willard and Pemberton came to the conclusion that it would have been better if only the most efficient of these had been utilized. This view was opposed, however, by Smith, a noted Californian expert on biological control methods, and his arguments are very convincing. In the work on local parasites of *Sexava,* Smith's ideas were followed, and an attempt was made to introduce several parasites from Lavongai to Manus, most important of them being *Dorinia leefmansi.* Unfortunately, however, these parasites, though doing excellent work in Lavongai, are by no means as robust as *Leefmansia bicolor,* the Amboina parasite, and their introduction to Manus has as yet shown no signs of success.

In no part of the world has biological control been more successful than in the Hawaiian Islands. In these islands an immense amount of work has been done by Muir, Perkins and others, employed by the Hawaiian Sugar Planters' Association. Muir, writing shortly before his death in 1931, ascribed the signal success obtained to two main factors, namely, the peculiar biological conditions existing in Hawaii, and the recognition of these factors by the entomologists resident there. The peculiar biological conditions alluded to are worthy of some discussion. The Hawaiian islands are the tops of a lofty chain of mountains which rises from the bottom of the sea, and extends from the north-west to the south-east. With the exception of a few deposits of mud and coral, the islands are composed entirely of volcanic rock. From this fact, and from the unique nature of the flora and fauna, we can conclude that the land is purely oceanic in origin. It rose slowly from the ocean, and was built up by outpourings of lava over a long period of time. The islands were never joined up to any large continental land mass, and this accounts for the peculiar nature of the flora and fauna. Only such plants and animals as could be borne by birds, or by the wind, or on floating logs and similar material could establish themselves. Muir claimed that even to-day it may truthfully be said that in a broad sense the native flora and fauna are composed almost entirely of types that arrived in this way, or their descendants.

Later on, primitive man arrived, bringing with him domestic plants and various insects attacking them, and by cultivating the food-plants of the insects, he provided them with plentiful sustenance, which, in conjunction with the suitable climate, provided ideal conditions for their rapid multiplication. However, many of these insects had parasites in the country of their origin, which, in the course of ages, had adapted themselves to the particular species concerned, or to closely allied species, and when they were introduced, they also found abundant food and suitable climate, and consequently, in many cases, proved very effective in controlling the injurious insects concerned.

So far, the discussion has been confined to the introduction of parasites from one faunal region to another, but there is a further aspect of the question which should be considered, namely, the breeding and dispersal of parasites already present in a region. At first sight this does not seem a very promising line of activity, because one would imagine that if the conditions were favorable for the spread of such an insect, it would spread without the aid of man, and that its failure to do so should be sufficient evidence that it could not be a success. Nevertheless, attempts in this direction have sometimes met with success, particularly when done on a large scale. One of the best examples is to be found in the annual breeding and distribution of the lady-bird beetle *Cryptolaemus montrouzieri*, an insect predaceous on the *citrophilous* mealy bug in California. The lady-bird is not a native of California, having been brought from Australia in 1892 as a parasite of the mealy bug. However, it did not come up to expectations, for though every now and then it succeeded in controlling an outbreak of the pest, its efforts were too spasmodic, and usually too late in the season to be of any real value. By the year 1916, however, it had firmly established itself in the fauna of California, so it can be taken as an example of an insect already existing in a faunal region.

The Californian entomologists concluded that the trouble with *Cryptolaemus* was that it destroyed an outbreak of mealy bug and was then starved out, as it confined its feeding strictly to the one insect. Thus, when a fresh outbreak of the pest occurred, the lady-bird took a long time to breed up again, with the result that its beneficial effects were spasmodic. They considered therefore, that if they could keep a constant large supply of *Cryptolaemus* on hand, they would be able to distribute the parasite whenever it was called for by an outbreak of mealy bug, and thus give it an opportunity to cope with its host. The chief difficulty in this scheme was to evolve a satisfactory technique for breeding the beetle throughout the year. At first, the food used was green citrus fruits, chiefly lemons. Unfortunately, however, the laboratory conditions suitable for the welfare of the host plant and for that of the mealy-bug were not compatible. Gas heat was necessary for the rapid development of the mealy bugs, but it had the effect of curing the fruit and toughening the skin in such a short time that the insects either died or migrated unsuccessfully in search of more suitable food. It was at this juncture that the use of potato sprouts was initiated, and it proved a great success. A little experience in the technique of this method led to the production of a continual supply of mealy bugs on which to feed the lady-birds, and so large numbers of *Cryptolaemus* were available for distribution when required. The work of breeding and distribution has been aided considerably by the erection of branch insectaries in various countries of California, together with private insectaries on the properties of some of the more important citrus growers.

Often, ignorance of a very small detail in the life-history of a parasite will hold up successful breeding, and as often as not it is by chance that a solution is arrived at. A good illustration of this is the case of the introduction of a wasp, *Meteorus versicolor,* from France to the United States of America, for use in the control of the Gipsy Moth. Almost all parasitic *Hymenoptera* (the order which includes ants, bees and wasps) deposit eggs whether fertilized by a male or not, the unfertilized eggs almost always producing only males. Hence it is important to see that mating takes place, in order that both sexes may be available for breeding. The imported Gipsy Moth parasites laid freely in the caterpillars of their host, and in due course cocoons were spun and wasps emerged. However, they proved to be all males, indicating that mating had not taken place in the first instance. Further attempts were equally unsuccessful, so that finally it was decided to liberate in the field a small colony of the parasites bred from imported material. This colony was put in a glass tube, and, in the course of its being carried to the woods, it was struck by the direct rays of the sun. Immediately mating took place. It was then recognized that sunlight was necessary to induce mating, and from that time onward no difficulty was experienced in breeding the wasp.

The foregoing remarks should serve to show what a fascinating pursuit the study of biological control can be, and also what wonderful successes it is capable of achieving. But it also gives some indications of the many disappointments that are met with, and the amount of thought and labour that may be expended before any tangible result is obtained. Nevertheless, every day the fund of knowledge regarding our insect friends is being augmented, and the time may come when most of the worst insect pests will be controlled by means of parasites.

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# CHARCOAL MANUFACTURE FROM COCO-NUT SHELL.

*By F. C. Cooke.*

[Extract from the *Malayan Agricultural Journal*, Vol. XXIII., April, 1935.]

When coco-nut shell is heated in a closed space without the presence of air, decomposition ensues, resulting in the formation of charcoal and in the evolution of large quantities of volatile products which can be recovered only by using an efficient retort and condensing plant. If charcoal alone is required, but no volatile by-products, it is sufficient to carbonize the shells in a stack or pit.

## Methods of Manufacture.

The shells used require a certain amount of selecting, as pieces with husk adhering yield a tarry or dirty product. Thin shells should be discarded and only shells from fully matured nuts, and those that have a clean bald surface selected.

The normal method of charcoal manufacture practised in Malaya is the age-old method of burning in turf or mud-sealed heaps. The enclosed heap is fired and when the shells are thoroughly burning, the supply of air is cut off, carbonization proceeding without further combustion. This primitive method is capable of producing good charcoal.

A tall stake is driven into the ground and shells are built round it to a height of about 4 feet. The pile is then covered with earth and grass which is damped. The stake is removed and fire inserted after which the heap is sealed and allowed to burn for 12 hours. In the morning the pile is doused with water and allowed to cool off.

On certain estates, the process is simplified still further by merely throwing water on a large, burning, uncovered heap of shells. This results in a charcoal which is not uniform, and which is of an inferior quality.

In Ceylon, where in coco-nut districts it is possible to excavate without reaching water, pits from 4 to 6 feet deep are filled to the top with shells which are then covered with green fronds and damp turf, sealed with earth and the shells fired.

There are two alternative methods of procedure. In one, fire of shells is started at the bottom of the pit, more shells are added until the pit is full and when these are well alight the fire is sprinkled with water until the flames have died down. The glowing mass is then covered with damp fronds, turf and earth, and left for twelve hours. Alternatively, a large pit 6 feet deep and 8 feet in diameter is dug; a hollow bamboo pipe is placed vertically in the centre and the pit is filled to ground level with shells. Paraffin is poured down the pipe and lit, after which water is sprinkled over the burning shells. They are then completely smothered with wet fronds, sacking and earth and left overnight.

## Requirements and Specification.

The distillation of creosote and other by-products from the shells must be practically complete as, for use in cooking, the object is to obtain a smokeless fuel. For chemical purposes, the charcoal will not act as an absorbent if the pores of the charcoal are clogged. In the production of producer gas for use in suction gas engines, the object is to obtain maximum gas output and to keep the fouling of the scrubbers and filters to a minimum.

A London firm of importers gave the following specifications:—

(a) Not more than 15 per cent. volatiles.
(b) Not more than 10 per cent. moisture.
(c) Pieces to be of a size, not less than 10 per cent., remaining in a mesh with 1-inch holes; nor more than 5 per cent. passing through a mesh with ¼-inch holes.

Requirement (c) is severe for there may be considerable damage and breakdown during shipment.

## Properties of Coco-nut Charcoal.

An actual sample of Malayan charcoal received which contained 25 per cent. moisture, gave 5,730 calories as the calorific value. This in terms of dry charcoal is equivalent to a gross calorific value of 7,640 calories.

Pieces of charcoal of good quality are uniformly dark, and free from adherent dirt due to husk. When dropped on a stone floor such pieces emit a clear bell-like ring and the broken edges show a black lustrous surface with a sharp conchoidal fracture. A badly burnt piece will emit a dull sound, and its broken surface is dull, dirty and irregular. An overburnt piece is very thin and has a smooth wavy indented edge beginning to curl. Thin overburnt pieces are very brittle, and are therefore unsuitable for inclusion for export as they are quickly reduced to dust.

Great care, experience and skill are required if the necessary high quality is to be obtained and slight misjudgment may result in a mixed mass of woody half-burnt charcoal, as a result of incomplete combustion, or a low yield of thin brittle copra through over-ventilation or over-burning. It will be appreciated, therefore, that the training of the operators may be a lengthy process and many batches of charcoal may be spoiled before the necessary skill and judgment are acquired.

## Yields.

The theoretical yield of shell charcoal is half the weight of the coco-nut shell. In practice, 25 per cent., or even considerably less, is obtained according to the efficiency of production and the thickness of the original shell.

An approximate formula for estimating the number of shells required per picul of charcoal (133⅓ lb.) is four times the number of nuts required per picul of copra, e.g., 250 nuts per picul of copra equals 1,000 shells per picul of charcoal.

If shells are also to be used as fuel in the copra kiln, it would not be safe to assume that more than 30 per cent. of the total shells would be available or suitable for conversion into charcoal.

## Cost of Production.

In one instance, charcoal is now being manufactured and bagged on contract at the rate of 28 Straits cents per picul. Three bags are required per two piculs of charcoal and this together with handling and road transport brings the total cost to about 60 cents per picul f.o.b.

The conference tariff on coco-nut charcoal is about 72s. per long ton ex ocean port, less 10 per cent. deferred rebate. Cost of production, above, is equal to about 25s. per ton. Selling charge, insurance, &c., bring the total c.i.f. cost to about £5 per ton.

In view of the possible local extras not included above, an all-in cost of £6 per ton should be allowed.

### The Market.

In 1931, the price offered by European buyers was between £10 and £11 per ton, but a more recent quotation was as low as £7 per ton delivered. Demand has hitherto been neither large nor sustained. In Ceylon, there is a considerable industry, the charcoal produced being either sold in the villages for kitchen use; for use in laundries; for conversion into producer gas; or for consumption in smelting works in Colombo. In Malaya, the bulk of the charcoal used for cooking purposes is obtained from baku wood and the local demand is somewhat limited.

# REPORT ON SOIL SAMPLES FORWARDED BY THE DIRECTOR OF AGRICULTURE, RABAUL, NEW GUINEA, TO THE WAITE AGRICULTURAL RESEARCH INSTITUTE.

## 1. Soils from Talasea District, Island of New Britain, New Guinea.

Twenty-four soil samples, representing five profiles to a depth of 72 inches have been examined.

These soil profiles have formed upon geologically recent, layered deposits of volcanic ash and are in consequence extremely immature in their development. From an examination of the pumiceous and other stone within the profiles and from a consideration of the mechanical analyses of the soils, it is apparent that a number of ash showers were deposited in the area, one on top of the other. At least three distinct layers in which the material varies from distinctly pumiceous to andesitic or rhyolitic in character are to be observed in each profile. The andesitic type of parent material is apparently dominant throughout the soils although, as in the lower layers of profile five, the rhyolitic type may be pronounced.

While the surface layer of the soils to a depth of about 12 inches is practically free from stone, about 6 per cent. of pumiceous material occurs in the second foot. The pumiceous stone reaches a maximum concentration of as high as 30 per cent. in the third or fourth foot, where lumps of pumice up to several inches in diameter may be found. Below 3 feet the lumps of pumice decrease in size and amount, their place being taken by less scoreaceous and smaller fragments of rhyolitic or andesitic material. In the lower depths, below 4 feet, these latter fragments together with glassy material and large grains of heavy minerals are present, to the virtual exclusion of pumice within the gravel fraction.

The soil profile consists of a 12-inch surface layer of a dark brown to grey yellow brown loam to clay loam, rich in organic matter overlying a light brown to yellow brown sandy loam to clay loam. To this depth of 24 inches the soils have a distinctly silty feel and a comparison of their mechanical analyses with those for soil formed from similar parent volcanic ash in New Zealand would suggest that they fall within the silt loam class. Below 24 inches the soils consist of pumiceous or andesitic or rhyolitic extremely sandy deposits yellow brown to yellow in colour, the yellow shade increasing markedly with depth.

There is little variation in the reaction values of the soils from profile to profile, although within the profiles themselves a change from slight acidity in the surface to neutral at the lower depth is to be noted.

The soils in the surface are well supplied with plant foods, the nitrogen, phosphoric acid and potash contents showing mean values of 0.4 per cent., 0.25 per cent. and 0.14 per cent., respectively. While there is a distinct decrease in the content of the nitrogen and phosphoric acid in the second foot, the potash content rises slightly.

The mechanical analyses and chemical data for the soils are given in the accompanying table. (Table 1.)

## 2. Soils from Upper Ramu Valley, New Guinea.

Two soil profiles, one from the alluvial flats and a second representative of the hill slopes from the Upper Ramu Valley, northern New Guinea, have been examined.

The profiles are essentially similar, being typically podsolized soils. They consist of a surface black to grey-black sandy loam, rich in organic matter to a depth of 12 inches, overlying a grey to yellow brown mottled sandy clay or light clay subsoil. Ferruginous gravel to the extent of about 27 per cent. occurs in the alluvial profile and to the extent of about 40 per cent. in the second profile.

The soils are distinctly acid. In the surface the pH values lie between pH 5.0 and pH 5.5, and rise gradually to a pH of over 6 in the subsoil.

The soils contain an adequate supply of plant nutrients as shown by Table 2.

J. S. HOSKING.

TABLE I.

SOIL SAMPLES FROM TALASEA DISTRICT, ISLAND OF NEW BRITAIN, NEW GUINEA, FORWARDED BY THE DIRECTOR OF AGRICULTURE, RABAUL, NEW GUINEA.

| Locality Site Number. | 1 | | | 2 | | 3 | | | | | | 4 | | | 5 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Waite Institute Sample Number. | 5065 | 5066 | 5067 | 5074 | 5075 | 5078 | 5079 | 5080 | 5081 | 5082 | 5083 | 5088 | 5089 | 5090 | 5097 | 5098 | 5099 | 5100 |
| Depth in Inches. | 0–12 | 12–24 | 24–36 | 0–12 | 12–24 | 0–6 | 6–12 | 12–24 | 24–36 | 36–48 | 48–72 | 0–12 | 12–24 | 24–36 | 0–6 | 6–24 | 24–48 | 48–72 |
| | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % | % |
| Stone .. .. | .. | 5.3 | 30.1 | .. | 5.2 | .. | 1.4 | 5.8 | 29.3 | 18.1 | 18.2 | 2.3 | 8.3 | 15.2 | .. | 8.2 | 1.9 | .. |
| Fine Earth .. | 100.0 | 94.7 | 69.9 | 100.0 | 94.8 | 100.0 | 98.6 | 94.2 | 70.7 | 81.9 | 81.8 | 97.7 | 91.7 | 84.8 | 100.0 | 91.8 | 98.1 | 100.0 |
| Coarse sand .. | 9.0 | 36.3 | 63.5 | 11.9 | 7.5 | 9.0 | 3.6 | 5.1 | 61.1 | 77.8 | 71.4 | 14.6 | 33.7 | 74.0 | 11.2 | 15.8 | 46.0 | 50.7 |
| Fine sand .. | 28.3 | 30.8 | 23.2 | 33.6 | 35.7 | 26.9 | 18.3 | 27.1 | 24.0 | 13.8 | 17.6 | 24.6 | 22.4 | 18.1 | 27.4 | 20.4 | 34.5 | 14.9 |
| Silt .. .. | 18.9 | 15.9 | 6.2 | 17.5 | 18.5 | 18.2 | 19.3 | 33.1 | 6.5 | 3.5 | 3.8 | 24.9 | 16.0 | 2.1 | 18.4 | 19.8 | 9.0 | 14.8 |
| Clay .. .. | 24.5 | 4.1 | 1.7 | 13.2 | 20.7 | 25.1 | 36.0 | 18.6 | 2.1 | 1.1 | 2.4 | 13.7 | 8.8 | 1.4 | 17.1 | 18.2 | 3.8 | 7.0 |
| Loss on Acid Treatment .. .. | 2.9 | 2.0 | 1.4 | 2.1 | 1.6 | 2.3 | 1.8 | 1.9 | 1.3 | 1.1 | 1.3 | 2.5 | 1.5 | 1.1 | 2.9 | 1.5 | 1.4 | 1.2 |
| Moisture .. | 13.3 | 10.7 | 4.4 | 18.3 | 17.8 | 13.8 | 21.1 | 17.1 | 5.6 | 3.5 | 3.9 | 20.0 | 12.6 | 3.2 | 19.9 | 27.3 | 6.0 | 12.6 |
| Loss on Ignition.. | 13.9 | 5.7 | 2.2 | 8.8 | 7.1 | 13.0 | 8.5 | 8.3 | 3.5 | 2.3 | 2.3 | 9.8 | 6.7 | 2.3 | 13.6 | 7.1 | 3.8 | 5.1 |
| Phosphoric Acid $P_2O_5$ .. .. | 0.33 | 0.09 | .. | 0.26 | 0.14 | 0.31 | 0.16 | 0.10 | .. | 0.07 | .. | 0.17 | 0.11 | .. | 0.18 | 0.08 | .. | .. |
| Potash $K_2O$ .. | 0.18 | 0.31 | .. | 0.13 | 0.18 | 0.15 | 0.15 | 0.23 | .. | 0.16 | .. | 0.11 | 0.13 | .. | 0.14 | 0.13 | .. | .. |
| Nitrogen N .. | 0.51 | 0.04 | .. | 0.33 | 0.05 | 0.47 | 0.15 | 0.06 | .. | .. | .. | 0.28 | 0.02 | .. | 0.53 | 0.12 | .. | .. |
| Soil Reaction pH.. | 6.6 | 6.8 | 7.1 | 6.4 | 6.8 | 6.2 | 6.6 | 6.7 | 6.2 | 6.7 | 6.8 | 6.6 | 6.5 | 6.5 | 6.9 | 6.5 | 6.7 | 7.0 |

| Soil No. | Depth in inches. | % stone. | pH. |
|---|---|---|---|
| 5068 | 36–48 | 24.2 | 7.3 |
| 5069 | 48–72 | 19.3 | 7.2 |
| 5076 | 24–48 | 2.6 | 6.8 |
| 5077 | 48–72 | 10.2 | 6.9 |
| 5091 | 36–48 | 28.3 | 7.0 |
| 5092 | 48–60 | 12.5 | 6.9 |

TABLE 2.

SOIL SAMPLES FROM UPPER RAMU DISTRICT, NEW GUINEA, SUPPLIED BY THE DIRECTOR OF AGRICULTURE, RABAUL, NEW GUINEA.

| Locality. | Profile Number. | Waite Institute Sample Number. | Depth in Inches. | Moisture. | Loss on Ignition. | * Soil Reaction. | Nitrogen. | $K_2O$.† | $P_2O_5$.† |
|---|---|---|---|---|---|---|---|---|---|
| | | | | % | % | pH. | % | % | % |
| Alluvial flats .. | 1 | 5049 | Surface | 6.48 | 14.08 | 5.2 | 0.36 | 0.12 | 0.11 |
| | | 5050 | 6 | 8.47 | 13.15 | 5.4 | 0.34 | 0.12 | 0.10 |
| | | 5051 | 9 | 7.64 | 12.24 | 5.8 | .. | .. | .. |
| | | 5052 | 12 | 6.03 | 10.88 | 6.0 | 0.23 | 0.10 | 0.09 |
| | | 5053 | 16 | 5.68 | 10.33 | 6.3 | .. | .. | .. |
| | | 5054 | 24 | 3.59 | 6.86 | 6.3 | 0.08 | .. | .. |
| | | 5055 | 36 | 3.94 | 6.04 | 6.0 | .. | 0.19 | 0.03 |
| Slopes and Undulations .. .. | 2 | 5056 | Surface | 11.10 | 14.26 | 5.5 | 0.31 | 0.10 | 0.12 |
| | | 5057 | 6 | 8.61 | 14.36 | 6.2 | 0.24 | 0.07 | 0.12 |
| | | 5058 | 9 | 9.10 | 14.13 | 6.2 | .. | .. | .. |
| | | 5059 | 12 | 13.03 | 13.30 | 6.1 | 0.19 | 0.10 | 0.11 |
| | | 5060 | 16 | 8.71 | 13.49 | 6.4 | .. | .. | .. |
| | | 5061 | 24 | 11.70 | 11.32 | 6.3 | 0.08 | .. | .. |
| | | 5062 | 36 | 10.15 | 10.60 | 6.3 | .. | 0.13 | 0.07 |

NOTE.—All figures obtained on air dried samples.
* pH values obtained with the Glass electrode using a soil : water ratio of 2.5 : 1.
† $K_2O$ and $P_2O_5$ determinations on the Stand and hydrochloric acid Extraction.

# WHAT TO GROW IN THE ISLANDS.

## HOW THE NEW GUINEA DEPARTMENT OF AGRICULTURE IS EXPERIMENTING TO ASSIST PLANTERS.

A very valuable and interesting review of agriculture and recent developments in primary production in the Mandated Territory of New Guinea was given by Mr. George H. Murray, New Guinea Director of Agriculture, in an address delivered to members of the New South Wales branch of the Australian Institute of Agricultural Science.

The peculiar merit of the address lies in the fact that Mr. Murray, in addition to giving his expert agricultural knowledge, has made an economic survey of the possibilities of the various plants.

The substance of the address is outlined in the following paragraphs:—

The Mandated Territory of New Guinea, which includes the Bismarck Archipelago, contains about 91,000 square miles. In this vast area climatic conditions vary from the humid lowlands near the coast to the cool mountain peaks over 12,000 feet high suitable for the growth of every crop of equatorial regions. In the early days of the German régime practically all the settlements were confined to the coast. Coco-nuts, being easily grown and suitable for such districts, were the first crops to be cultivated, and remain the staple product to this day, our export of copra being approximately 60,000 tons per annum. (The returns for the year ended 30th June, 1937, being over 76,000 tons.)

In the early days of coco-nut planting in the Pacific, methods of cultivation were more primitive than they are to-day on well-managed coco-nut estates in Malaya and Ceylon. The coco-nuts were planted more or less regularly 28 to 30 feet apart each way and they received very little cultivation, other than to keep the grass cut down, which, as cultivation, is hardly worthy of the name. Several of the plantations in the early stages of the German régime were inter-planted with cotton, the cultivation of which also helped the coco-nuts, and the cotton crop was of some assistance in reducing the labour costs. The low price of cotton to-day, however, hardly warrants the cultivation of cotton in New Guinea even for this purpose.

It should be remembered that there is practically no resting period in plant growth in the tropics, particularly in districts with heavy rainfall. Consequently, weeds are growing all the time, and the methods employed in orchard cultivation in temperate zones are quite inapplicable in the humid tropics. About 25 years ago, therefore, selective weeding and use of cover plants came into practice. The former meant encouraging the growth of leguminous weeds to combat those of an injurious nature.

### Cover Crops.

*Passiflora foetida* was one of the first to be used as a cover plant in competition with the noxious grass, *Imperata arundinacea,* known by various names, in the eastern tropics to which it is confined: In Ceylon it is known as Illuk, in Malaya and the East Indies as Lalang, corruption of the Malay name alang alang, in the Philippines as Cogon, in the Territory of New Guinea as Kunai, in Papua by its Motuan name of Kuru Kuru, and commonly known in the warmer parts of Australia as blady grass. Its growth in Australia, except in North Queensland, is much less rank than in New Guinea. Incidentally, this grass can be manufactured into paper, a sample of which is on show at the Agriculture Department, Rabaul. Such an industry could never be worked on a profitable basis, however, except on an extensive scale, where the grass could be cut by machinery.

Although *Passiflora* has proved successful in combating kunai in New Guinea, where soil conditions are favorable, it proved quite unsuitable in heavy soil in certain parts of Papua. It is non-leguminous and for that reason was not a satisfactory cover. Experiments over a long period were carried out with other leguminous plants for the control of weeds and noxious grasses and the two creepers *Centrosema pubescens* and *Calopogonium mucunoides* are now in general use for this purpose in the East Indies, and have proved eminently suitable in New Guinea. There was great opposition to and criticism of the use of leguminous cover plants when first recommended by the New Guinea Department of Agriculture, the planters being wedded to the old method of cutting the kunai—with scythes made of suitable sharpened hoop iron—formerly practised by Germans in the early days before the more scientific method of cover plants came into use. Many planters to-day, however, are using cover plants on their plantations, one of whom informed me that since he had established these plants on his property he was able to dispense with a gang of 60 grass cutters. Another plantation of approximately 500 acres is entirely covered with such plants, not a single labourer being employed in weed control. *Centrosema pubescens* takes a considerable time to get established, six to twelve months, but *Calopogonium* grows very rapidly once the plant commences to run, and one planter, who says he cannot remember its name, calls it "galloping home". The latter plant dies back during a continuously long period of dry weather, but the former makes a permanent cover when once established.

In very shallow soil neither plant grows satisfactorily, but coco-nuts will not thrive in such soil either.

### Copra Curing Methods.

Copra, the cured meat of the coco-nut, is prepared for market by drying in the sun, over smoke fires, or in specially constructed driers heated by hot air, or in a few cases by steam. The sun-cured copra is the best quality, but only districts having considerable sunshine are suitable for this method. What is known as the Ceylon type of drier is the most satisfactory artificial method of drying. Even with this method, however, it is advisable to give the green (uncured) copra one day in the sun before putting in the drier. This method necessitates transferring the copra from one platform to another for five consecutive days after which it should be of first-class quality. This method was recommended to the planters in New Guinea and plans and particulars supplied by the Department of Agriculture.

Like many new methods that have been recommended it received criticism in certain quarters. One company after a short trial condemned it for the reason that it was said to require 44 units to produce one ton of copra. Another planter in his first attempt at curing in accordance with this method cured his copra at a labour cost of 34 units to the ton, but there can be no doubt that after his labourers were thoroughly accustomed to the work the labour costs could be greatly reduced. This has been proved, as another planter who has always followed the advice of the Department of Agriculture informed me that his labour cost was 17 units per ton, and he has been producing first class copra, obtaining a considerably higher price than Rabaul sun-dried. The coco-nut planter in New Guinea and elsewhere must realize that the only way to make his plantation pay to-day is to reduce costs of plantation maintenance and improve the quality of his copra by curing in some such method as the Ceylon type of drier. This drier can be modified to suit large or small properties. That such methods are practicable is proved by the fact that a large estate of 18,000 acres in Malaya produces copra at an all-in-cost of less than £5 per ton f.o.b.

Every endeavour is being made by the Department of Agriculture to raise the standard of New Guinea copra by a system of copra inspection by qualified inspectors. The scheme of copra inspection has raised the standard of our copra so that planters have received as much as 25s. per ton over South Sea at which New Guinea copra was previously rated.

### Sexava Insect Pest.

Coco-nuts in New Guinea are comparatively free from serious disease, but they are subject to attack by several insect pests common to the Pacific. We have, however, a very serious pest in New Guinea so far unknown to other Pacific islands, but very closely akin to a species in Moluccas and the Taland Group of islands in the Dutch East Indies. It belongs to the family *Tettigoniidae* and the genus *Sexava*. These insects may frequently be present on a plantation for years, but not in sufficient numbers to cause serious damage. Then they may suddenly increase with alarming rapidity, reaching plague proportions. The insects can best be described as long horned tree hoppers, sturdily built and about 4 inches long. They are ravenous eaters and the noise made in the evening by eating resembles a gentle breeze through the tops of the palms. Palms that have been heavily attacked are often stripped of their foliage and resemble an umbrella frame.

Ordinary methods of insect control are quite inapplicable for such a pest. In studying the problem I found that the same, or kindred insect, was found in Amboina in the Moluccas, where it was kept under control by a minute Chalcid wasp, *Leefmansia bicolor*, parasite on the *Sexava* egg. After correspondence with Dr. Leefmans, Director of the Institute of Plant Diseases, Buitenzorg, Java, recommendations were submitted for the introduction of the parasites from the Moluccas to New Guinea and a Government schooner left Rabaul for Amboina with Mr. J. L. Froggatt, entomologist, on board. Mr. Froggatt succeeded in obtaining a large number of parasitized eggs and landed them safely at a field laboratory at Manus, in the charge of Mr. J. F. Caldwell.

Many thousands of local *Sexava* eggs were duly parasitized by the *Leefmansia* and breeding operations were then established. The parasites have been obtained from *Sexava* eggs collected in the field, and we have good reason to believe that they are established in the district. The field laboratory was later removed to New Hanover under Mr. B. O'Connor and his reports showed that the parasites gradually distributed themselves in *Sexava* infested areas on the island. It is too soon yet to say what the ultimate result will be, but we certainly have good reason to hope that this campaign against *Sexava* will be a success.

## Other Island Crops.

It is very unwise that any country should depend upon one crop for its agricultural development, and the Department has made every effort to encourage the cultivation of crops other than coco-nuts. About the middle of 1928 operations were started for the development of the Keravat Demonstration Plantation, about 30 miles from Rabaul. Contrary to what has been said in certain quarters our records show that many experiments and introductions of new crop plants have been made there.

Apparently many planters and even officials have the idea that there are many tropical crops at present not cultivated in New Guinea that can be grown profitably by Europeans. In New Guinea such however is not the case, particularly as the only districts at present accessible for development are those comparatively near the coast. Some tropical crops are suitable only for peasant cultivation, or on the other hand, on a very extensive scale, requiring expensive machinery.

Pimento, for which there is but a limited demand, is practically grown only in Jamaica where it is little more than a peasant crop.

Nutmegs take long years to come into bearing and the prices ruling would not justify any planter growing them extensively. It is a crop that requires careful handling and packing. There are a few trees bearing on some of the plantations to which the owners might well give their attention. The nutmegs are extremely subject to insect attack after harvesting and require careful packing. They should be packed in paper-lined boxes weighing 56 lb. each. The nutmegs should be wrapped in paper and the joins or seams of the boxes sealed with adhesive tape.

A few clove trees have also been introduced to New Guinea, but the market for this spice is limited, and more than supplied by Paemba and Zanzibar (British Protectorate) and the Moluccas, Dutch East Indies.

Pepper has been introduced by the Department and is coming into bearing at the Demonstration Plantation and Botanic Gardens. This crop takes about six years to be in full profit and requires as intensive cultivation as a market garden. Ordinarily, the stock of pepper on the London market is 4,000 tons, but there are at present 25,000 tons, and so this crop would be of no assistance in relieving planters in the present copra slump.

Arrow root, ginger, cardamons, and cinnamon are minor crops cultivated at the Demonstration Plantation and Botanic Gardens, Rabaul, but the planter would be ill-advised who entered on their culture extensively, owing to the limited market.

Vanilla, another minor crop grown at the Demonstration Plantation, has greater possibilities, but only as a side line. As is well known vanilla is an orchid, and in New Guinea must be hand-pollinated to get any crop.

The fibre plants, Manila hemp, Sanseviera hemp and Mauritius and jute are all grown at the Demonstration Plantation and the Botanical Gardens, Rabaul, but not one of these could be grown profitably in New Guinea at present, for reasons unnecessary to specify here. An improved variety or sub-species of Sisal hemp (also introduced to the Demonstration Plantation) could probably be grown profitably in New Guinea, but only if grown on a very extensive scale, and under able and skilled management. A great deal of expensive machinery would be necessary for the successful cultivation of the crop. The same applies to tapioca, although this crop is more easily dealt with. Its production, however, on a profitable commercial scale by European planters requires considerable financial resources on account of machinery for its preparation. This crop is also being grown at the Demonstration Plantation and experiments are to be made in its preparation by simpler methods.

Desiccated coco-nut is also produced, there being three mills in operation, but there is little likelihood of expansion in this industry for the moment.

### The Derris Plant.

The leguminous plant Derris is now receiving some attention as a plantation crop, and experiments are being made at the Demonstration Plantation in the cultivation of an introduced species, probably *Derris Malacceasis,* and the indigenous species at present unidentified. A small sample of New Guinea Derris was sent to the Imperial Institute in London, by the Department, and was favorably reported on. Its rotenone content was approximately 4 per cent. and considered equal to the Malay product. The rotenone content in this plant seems to be very variable, and until we have sufficient roots to make a trial shipment to London the Agriculture Department would not be justified in advising planters to enter upon its cultivation. It takes about 21 months from planting before the roots are ready for harvesting. The main toxic property in the roots is rotenone, which is now coming into use for insecticidal purposes.

Adlay, a cereal crop introduced from the Philippines, is growing very well at the Demonstration Plantation, but both Europeans and natives would need to acquire the taste for it before it could ever become an important crop in New Guinea. The grain, however, is appreciated by poultry.

The very few tropical crops left that could be grown profitably in New Guinea are cocoa, rubber, coffee (Robusta and Arabica), tea, cinchona, kapok, West African oil and sugar, all of which are cultivated at the Demonstration Plantation, while tea and cinchona have been introduced recently to the Upper Ramu at 6,000 feet.

### Cocoa, Rubber and Coffee.

During the German régime there was a considerable production of cocoa in the colony, but during military occupation such plantations were greatly neglected. Efforts are now being made to revive the industry and according to returns the exports of cocoa in 1936-37 amounted to 132 tons. Mr. E. C. Green, of the Department of Agriculture, who took a post-graduate course at the Imperial College of Tropical Agriculture in Trinidad, was advised before his departure from Rabaul to specialize on cocoa and after his return he was specially detailed to inspect cocoa plantations in the Territory and advise the growers as to how to improve their methods. Before my departure on leave, the Department received very appreciative letters on the work of this officer, and there has already been a decided improvement in some of the cocoa exported from the Territory.

Amongst the cocoa trees in the Botanic Gardens, Rabaul, there are a few trees yielding beans of good type, round full seeds and light colour in longitudinal section. These trees have been selected as mother trees for seed purposes and it has also been proposed to obtain some specially selected high quality plants from Java if regulations in that country permit.

A small coffee industry has been established, there being four plantations of Robusta now coming into bearing.

At the Agricultural Station, Wau, in the Morobe goldfields district, at an elevation of little more than 3,000 feet, the Department introduced Coffee Arabica of the famous Blue Mountain variety from Jamaica. Unfortunately, the station is in private hands, but the trees are yielding heavy crops of excellent quality which find a ready local market. The rich mountain lands on the Upper Ramu and many other parts of New Guinea are eminently suitable for Arabian coffee, high quality tea and cinchona, but it is useless to consider the cultivation of these crops until suitable roads have been constructed into the interior.

Owing to the large consumption of rubber in Australia there are possibilities of this crop being worked on a profitable basis if up-to-date methods are employed. No rubber is produced in the Mandated Territory of New Guinea, but there are plantations in Papua, though I doubt if the maximum yield of dry rubber per acre in the Territory is more than 700 lb. By modern methods of rubber planting now practised in the Dutch East Indies and Malaya, that is by planting budded trees from specially selected high yielding clones, 2,000 lb. per acre or more may ultimately be expected.

By an agreement between the main rubber producing countries it is impossible to get any plant material from these high yielding clones, but if a thorough investigation of the rubber tree were made in Papua by the estate managers there in co-operation with our Department, it is possible that we might discover clones equal to some of the record yielders of Sumatra and Java.

## SUMMARY.

1. *Rubber* at low and medium elevations.
2. *Cocoa* at low and medium elevations.
3. *Coffee* Robusta at low and medium elevations.
4. *Coffee,* Arabian, at elevations of 3,000 feet, and upwards.
5. *Tea,* Up-country at elevations of 3,000 to 5,000 feet.
6. *Tea,* Low-country is not proving at all profitable to-day.
7. *Kapok.* Can be grown successfully in many classes of soil, from near sea level to medium elevations.
8. *Sisal Hemp.* Did not prove profitable in New Guinea under German régime, owing partly to unsatisfactory labour. A new variety of species found at the Amani Agricultural Research Station is reported to have double the percentage of fibre as *Agave sisalana,* and to be of much finer quality. The director of that institution has been requested to forward a quantity of suckers to New Guinea for trial purposes.
9. *Tobacco.* There are possiblities for this crop in New Guinea. It is somewhat of a gambler's crop, however, yielding high returns at one time and proving a failure at others, owing to susceptibility to disease and insect attack.
10. *Cotton* has proved to be an unreliable crop owing to climatic conditions.

11. *Derris.* There seem to be reasonable prospects for the cultivation of this crop in New Guinea, as it is coming largely into use in certain insecticides. Several hundred plants were sent from the Botanic Gardens to the Keravat Demonstration Plantation, and the department for some time past has been obtaining information from buyers in England and America, and if the data supplied is sufficient to warrant its cultivation in New Guinea, a bulletin on the subject will be published by the department.

12. *Pepper* is hardly suitable for European cultivation. It is almost entirely grown by Chinese and Malays, and to yield remunerative crops must receive highly intensive cultivation like a market garden. Small quantities, however, are grown on European plantations in Java as a side line.

13. *Spices* and many other minor crops of the tropics are only suitable for peasant or native cultivation, and it will be seen, therefore, that the choice for the European planter is limited.

# COPRA DRYING—CEYLON DRIERS.

The type of hot air copra drier in general use in this Territory, and known as the New Guinea drier, consists of a large chamber containing a series of relatively shallow trays heated from beneath by a system of flues.

Such a system of drying, besides being costly, is scientifically unsound as there is no escape of moisture from the lower trays except through those above, with the result that the copra from the latter is partly steamed, and yet copra is supposed to be cured by such method in 20 to 24 hours.

In many cases where the owner gives careful personal supervision to his drier the product is clean when it leaves the drier, but even the best samples have the outside of many pieces case-hardened, and nearly always tinged with brown or oven-scorched, while the inside usually shows a waterline, a sure indication of imperfectly cured copra.

Owing largely to the work of the copra inspectors, the copra from this territory has been improved and maintained at a higher standard than that from neighbouring countries, with the result that it is known on the European market as Rabaul Hot Air obtaining 15s. to £1 5s. per ton more than South Sea.

This, however, is not enough, and there is no reason why planters here should not produce copra equal to the best from other parts of the world, but this can only be done by abandoning the rapid methods of drying long favoured in this territory.

First-class copra can only be cured by slow even heat, as free from draught as possible, and provided due care and supervision is given, such copra can be produced in driers of the attached plan,* one of the types, in common use in Ceylon.

On a compact plantation with good transport facilities it is advisable to bring the coco-nuts to a central depot adjoining the barbecue for husking and splitting, as the labourers are then under closer supervision than when such work is done in the field.

The nuts should be split into halves as early in the day as possible, and placed on the barbecue concave side up, providing, of course, that the weather is not wet or showery. If the weather is dry, an extra day in the sun is a great advantage, but in that case the half nuts should be covered at night with sheets of iron or other suitable material.

In the evening or the late afternoon of the first or second day as the case may be, the copra (half nuts) should be placed on the first day table of the drier.

Special half nut arrangement on the platform or table, although not absolutely necessary, is advisable. The bed of copra (half nuts) should consist of as few layers as possible for the first and second days, but on subsequent days it can be as much as 18 inches in depth, every precaution, however, being taken to prevent half nuts cupping one within the other.

Every day the copra should be transferred from one table to the adjoining, so that on the second day the copra that formed the top layer on the first day table will be at the bottom layer on the second table, a daily reversal which proceeds until the copra has reached the last table.

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* *See* pages 35–36.

In the plan shown on pages 35-36 only four tables are given, but where any district is subject to much wet weather so that the barbecues are not in use as much as could be wished, it would be necessary to have five or even six such tables.

In using this type of drier, firing is most important, and those who have not seen one in use before will need to watch the process very carefully at first, as a thorough knowledge of the right quantity of fuel and time required to cure the copra satisfactorily, can only be acquired by personal experience.

The fuel (coco-nut shells, *not husks*), should be stored at least three days in the verandah of the drier so as to be absolutely dry before use, and no more should be used than is absolutely necessary to produce an even steady heat. Too much fuel will be apt to scorch the copra and produce over-much smoke.

The object of this drier is to obtain a clean heat like that from a charcoal brazier, consequently it is necessary to give personal supervision to the work.

In wet weather it is sometimes advisable to use double rows of shell fuel, and in exceptional weather when the atmosphere is supercharged with moisture, drying may be suspended and only resumed when relatively dry again. It is, therefore, advisable to have an extra drier to deal with an accumulation of nuts after an unusually long spell of very wet weather. Considering, however, that the drier can be erected cheaply of native material, this is not a serious matter.

In very dry weather the shells will soon come away freely from the "meat", but in any case they will do so after a couple of days in the drier.

The fuel consisting of half shells, should be lined or cupped together on the floor of the fire pit in lines 2 feet apart across the pit, the concave sides facing alternate directions.

Under the first day table the shells should be laid in single lines 4 to 6 feet apart, so that the temperature will be approximately 122° Fahr.

Under the second and third day tables double firing should be adopted, i.e., two lines of shell 2 feet apart.

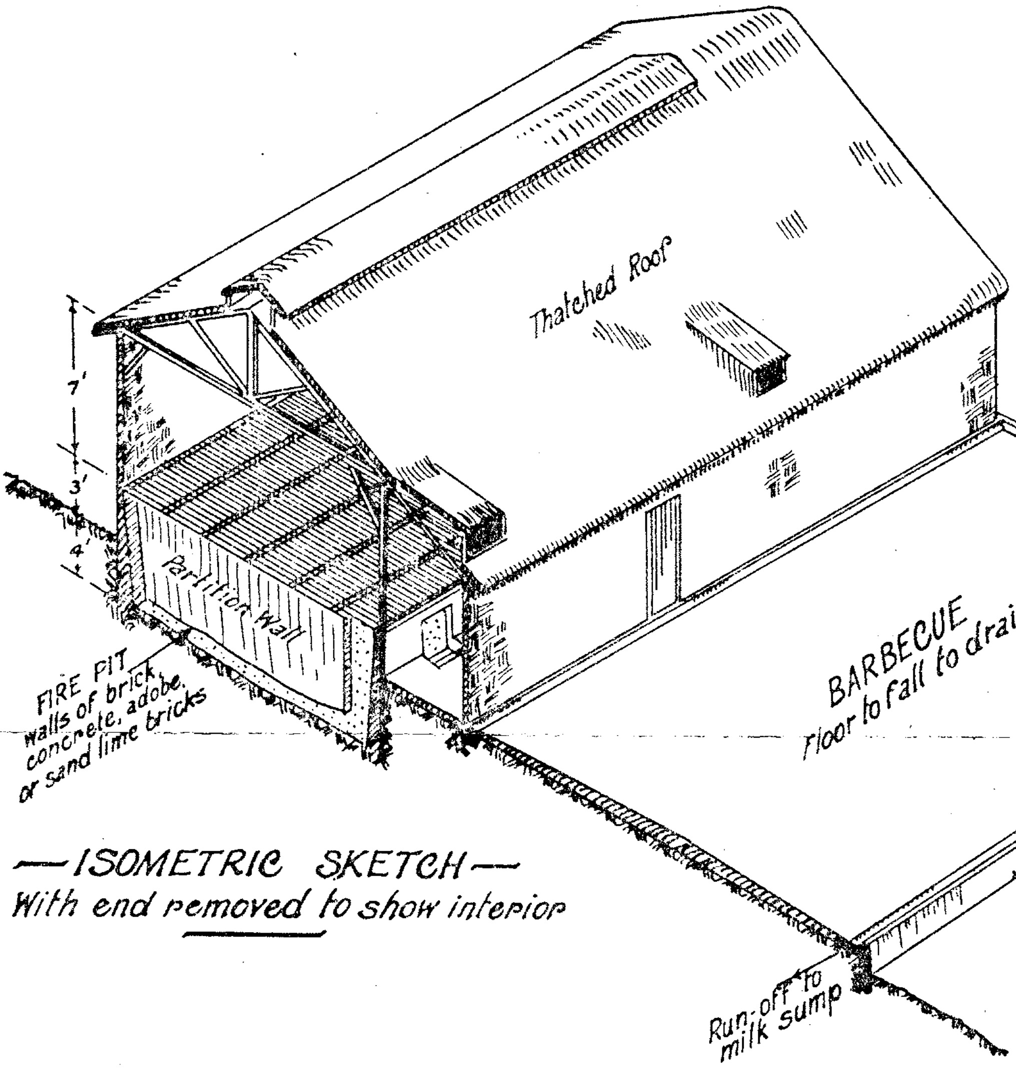
On the fourth day drying should be so far advanced that the wider single row firing should be sufficient, and due care must be taken at this stage as over firing will result in scorching or discolouration of the copra.

In starting the fires, every alternate line of fuel should be lighted at opposite ends, and they should, of course, be started before placing copra on the tables.

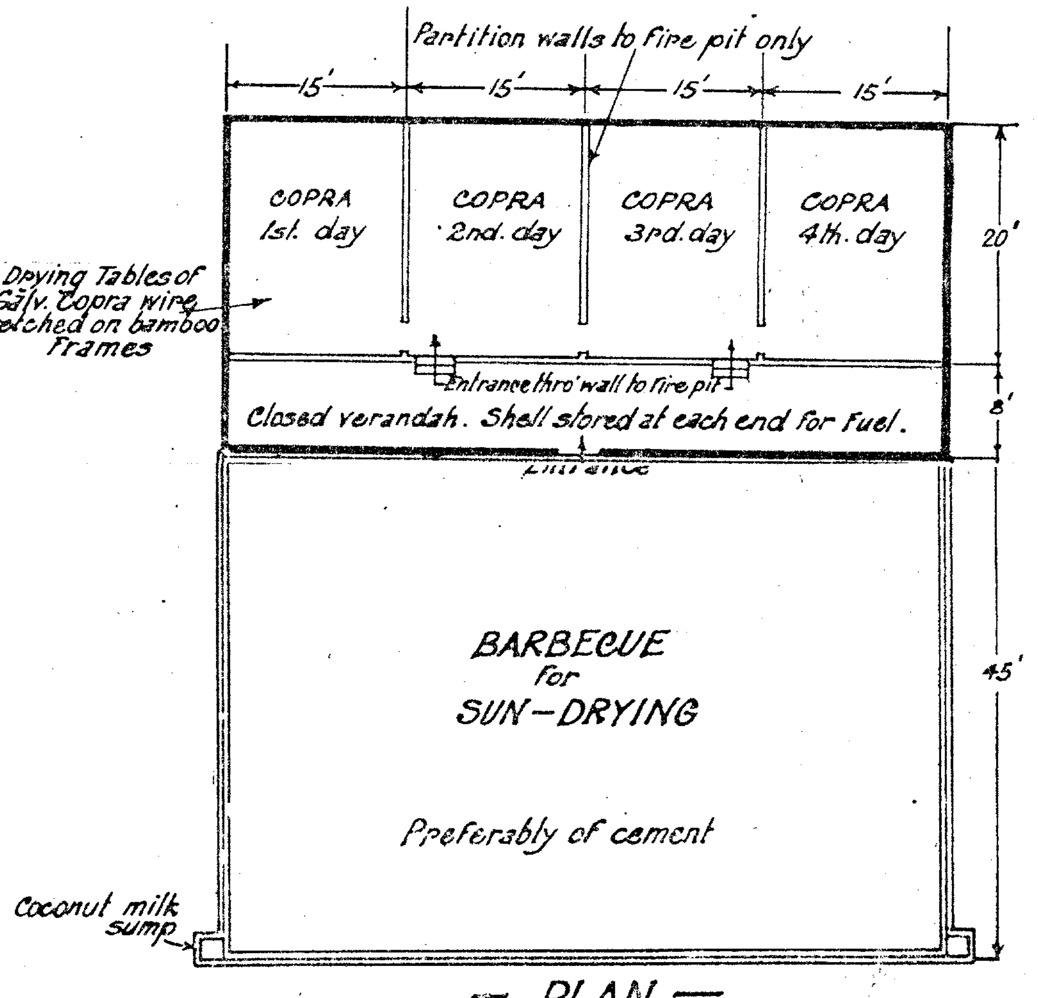
For several years past the Department of Agriculture had advocated the Ceylon method of copra production. Several planters erected driers according to plan, and turned out first-class copra, but discontinued the process on the grounds that the labour involved was too costly.

It should be remembered, however, that the process was entirely new, not only to the planter himself, but to the labourers, and it could not be expected, therefore, that they could produce copra at a minimum cost until they had had considerable practice.

Apparently the main objection was the cost of husking the nuts, but it must be remembered that it takes a native about two or three months to be sufficiently expert to husk 1,200 nuts per day. It has been proved in the territory, however, that our labourers can husk this number, if provided with suitable husking iron or strong sharpened stake firmly fixed on a solid foundation.




—ISOMETRIC SKETCH—
With end removed to show interior




— PLAN —
Scale 1" = 16 feet

DIAGRAM OF ONE TYPE OF CEYLON COPRA DRIER

# MEALY BUG ON COFFEE.

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

During investigations into an outbreak of "mealy bug" on coffee in this Territory, it was ascertained that the pest had first appeared on the *Erythrina* in the plantation, and later spread to the *Leucaena glauca* and coffee; the *Erythrina* was a local species, cuttings having been obtained for planting from the scrub about 1 mile from the coffee area.

A search in the surrounding scrub revealed that the *Erythrina* growing in its wild state was also heavily infested with a "mealy bug" apparently the same species as that in the plantation. Specimens from both the scrub *Erythrina* and the cultivated coffee were sent to Mr. F. Laing, British Museum of Natural History, London, who has identified both series of specimens as *Ferrisia virgata, Ckll,* with the comment "this mealy bug is rather common on a wide range of host plants throughout the tropics".

In view of the fact that the indigenous species of *Erythrina* is the host of a pest with a wide range of host plants, care should be exercised in its introduction into any area where economic plants are cultivated.

# RAINFALL NOTES.

*B. G. Challis.*

"What is it moulds the life of man?
The weather.
What makes some black and others tan?
The weather.
What makes the Zulu live in trees,
And Congo natives dress in leaves,
While others go in furs and freeze?
The weather."

W. J. Humphreys.
(*Weather Proverbs and Paradoxes.*)

Rainfall has a considerable influence on all crops. It regulates their germination, production and harvesting. It has a bearing on the life cycles of pests and incidence of diseases associated with various crops, while the period and quantities of its precipitation, whether light or heavy showers, makes all the difference on growth and yield. For instance, in New Guinea, it has been observed that the peak periods of coffee yield correspond with the periods of low rainfalls, and there is practically no yield during months of heavy rainfall.

Rainfall also greatly concerns many other items such as transport, factories, engineering and general public health matters and is of supreme importance for our domestic water supply in this territory where we have no irrigation or reticulation schemes or means of conserving water, other than by small domestic rainwater tanks.

Rain is a condensation of water vapour in the atmosphere in the form of drops which fall towards the earth, but may evaporate before reaching the ground. Clouds are usually the origin. If the temperature of the upper part of a cloud falls below the dew-point or temperature of complete saturation, large drops form round the comparatively few dust particles suspended in the atmosphere and these fall through the cloud, embodying the smaller drops round the more numerous dust nuclei in the lower part of the cloud as they pass, and emerging as quite large drops of water.

The distribution of rain is determined mainly by the direction and route of the prevailing winds, by the varying temperatures of the earth's surface over which they blow and the physiographical features generally.

The atmosphere has been described as "a vast still of which the sun is the furnace, and the sea the boiler while the cool air of the upper atmosphere and of the temperature zones plays the part of condenser, and we on a wet day catch some of the liquid which distills over."

The pressure of the atmosphere is an important factor in precipitation. At ordinary elevations it is not appreciable to the senses but its action is amply illustrated in a pump where a piston diminishes the pressure of air in the cylinder and the atmospheric pressure outside forces the water up the cylinder of the pump.

By correlating the various barometrical pressures over wide areas meteorologists are able to predict forecasts with a considerable measure of success.

When air ascends over high ground it expands because there is less air above; hence the pressure becomes less and it usually results in the loss of its water content. It then passes on as a dry wind and as it subsequently descends it will be warmed at 5½ degrees Fahrenheit for every 1,000 feet of descent as a result of compression when it comes down into levels of high pressure.

Generally speaking rainfall increases with elevation on the windward side of mountains up to a level of about 9,000 feet in New Guinea after which precipitation decreases with higher elevation.

The direct influence of rainfall on forests may be debated by some authorities, but there is a decided beneficial effect which warrants their extension and protection because they act as wind breaks, control evaporation and arrest soil erosion by wind or rain, one of the gravest concerns of agriculturists to-day throughout the world. Trees as wind breaks and controllers of soil erosion, could be successfully planted on kunai plains. They should be planted at right angles to the direction of the prevailing winds and if planted at distances of not less than half a mile apart, they will afford shelter for the enclosed areas. The abundant rainfall and uniformly high temperatures experienced in New Guinea will make for profuse growth.

Historical records prove however that the destruction of forests has ruined nations. Deserts to-day in parts of North Africa were once the granaries of the Roman Empire where Greek, Roman and Venetian cities thrived. The destruction of the forests caused an unequalizing effect on their climate, the shade temperatures and evaporation increased together with a higher relative humidity, with the consequence that the land became burnt up and those countries to-day form part of a great desert.

The forest countries of Palestine, Mesopotamia, Sicily and China, now barren, once supported a dense and prosperous people who cut down and burnt off their forests with disastrous results.

Lord Lugard in his *Dual Mandate* states—

> Forests serve as a reservoir which feeds the head-waters of streams, and with their destruction the torrential rains carry away the surface soil, and deposit sand and debris on the plains, thus rendering them unfit for cultivation, while the rivers cease to be navigable.

Trees distribute rain water evenly and allow the water to filter through to springs and rivers. Their canopy keeps the ground underneath cool and prevents the rapid drying up of the moisture by the heat of the surrounding atmosphere.

Tests have proved that about 90 per cent. of the rainfall is absorbed by the leaf mould of the forests and the distribution of such water takes a little over two years.

In the absence of forests no such conservation is made and with heavy rains the top soil and humus are washed away so that gradually the productiveness of the land declines, property values are reduced and unless preventive measures are adopted starvation will present itself.

A local example of the beneficial influence by partial clearing of a forest, on climate, may be observed in the Edie Creek area of the Morobe District.

In 1926, when the upper area of the Edie was discovered by Messrs. Royal and Glasson, the mountains and the slopes of the gorge, through which the creek flows, were heavily timbered down to the edge of the river bed. As the alluvial workings were developed, it was found that terraces and slopes of the gorge were rich in gold, and to work these, it became necessary to fell the forest on either side of the creek. Later still, when the large companies such as "Edie Creek Pty. Ltd.," "Day Dawn Ltd.," and "New Guinea Goldfields Ltd.," commenced operations on a large scale, huge areas of forests had to be felled and cleared to provide quarters, stores, roads and water races. The introduction of hundreds of native labourers further called for the provision of rigorous sanitation schemes to cope with the prevalence and danger of infectious diseases such as dysentery, etc. The only way to deal with such a danger, having regard to the ignorance of the native, and the difficulties of supervision over sanitary conditions in a thickly afforested area, was to clear and expose the whole of the locations where the natives were housed and employed.

In this way also vast areas were cleared of timber, and to-day the whole aspect of the Edie Creek area is quite unrecognizable from the densely timbered district of 1926.

The early prospectors and miners who invaded the rich alluvial area from 1926 to 1928 describe the misery and discomfort which prevailed at that time.

The ground was completely covered with a deep moss and humus, in which one sunk to one's ankles. Sunshine was conspicuous by its entire absence, under the dense canopy of the foliage, and an incessant moisture fell day and night from the low hung clouds and mist which lay just on the tree tops at this altitude of 7,000 feet. Hardly a day passed without its complement of rainfall, and the cold winds which blew through those gloomy mountain gorges made life an abject misery.

To-day the scene is completely changed. From an aeroplane one can trace the roads from Wau to the source of the Edie Creek. Huge mining camps lie exposed to the sun and terraces and gardens flourish in their new environment. Moss and fungus are non-existent, and except in very rainy weather, living conditions are very comfortable, and even more desirable than in the heat of the coastal areas. Warm sunshine, the absence of mist and the introduction of good motor roads have completely revolutionized the Edie Creek area, and those who live there to-day would not exchange their habitat for any other in the Territory.

If, however, the forest slopes are indiscriminately and completely cut away in these areas, erosion may occur and the only remedy (if adopted in time) will be re-afforestation and the planting up of thickly matted cover crops which have close packed roots.

Apart from forestry there is nothing man can do to influence rainfall. The theories that gunfire or other atmospheric concussion promotes rain is exploded by the fact that during the Great War in spite of the terrific and incessant bombardments, the rainfall in Europe was only about normal.

Rainfall is measured in terms of the depth of water which would be collected on a level area of any size supposing the rain to fall uniformly over the area at the rate at which it falls into the gauge. An inch of rain means 100 tons of water per acre, or about 64,000 tons to the square mile. For record purposes it is registered in a rain gauge and its amount is stated in the number of inches or millimeters. (To convert points of rain into millimeters divide by 40). It should always be recorded to tenths of a millimetre or to hundredths of an inch and it is desirable to note the time of beginning and ending of heavy showers. Any day on which one point (.01 inch) or more of rain is recorded is regarded as a rain day.

There are two types of rain gauges used, either 5 inches (12.5 centimeters) or 8 inches (20 centimeters) in diameter. The amount of rain measured in a rain gauge with a rim of 5 inches does not vary much from that measured in the gauge with a diameter of 8 inches, although the recorder must be careful to note that his glass or other measure is properly certified for either an 8-inch or 5-inch gauge, otherwise his recordings will be far from accurate as was proved recently when one plantation manager forwarded returns which appeared excessive coming from his particular district.

Instructions as issued by the Commonwealth Meteorologist in the use of a rain gauge were published in the last issue of this *Gazette*.

## The Measuring Glass.

With each instrument a graduated measuring glass is supplied, to a capacity of ½ inch of rain water. It is important to see that the proper gauge glass has been supplied, for ½ inch of rain will naturally give a much smaller volume of water in a 5-inch, than it does in an 8-inch gauge. On all reliable glasses, a figure is engraved showing the size of the gauge for which it is intended to be used.

Occasionally the measuring glass may be mislaid or broken. In such a case, before a new one is obtained, it is always possible to use a graduated ounce—or c.c.—measure from the nearest hospital. The area of a circle of 5 inches diameter is 19.64 square inches: 1 inch of rain will, therefore, be equivalent to a similar number of cubic inches of water, in such a gauge. And 19.64 cubic inches are equivalent to 324 c.c., or 11.4 fluid ounces. If, therefore, we measure 11.4 fluid ounces from the collecting glass of a 5-inch gauge, we know that it represents 1 inch of rain.

An 8-inch gauge has an area of 50.28 square inches, and 1 inch of rain will give approximately 29 fluid ounces, or 825 c.c.

The following table of reference will give an emergency reading for use in such circumstances, until a new measuring glass can be obtained.

## EMERGENCY TABLE FOR ESTIMATING RAINFALL WHEN THE RAIN-GAUGE GAUGE-GLASS IS MISLAID OR BROKEN.*

| With a 5-in. Rain-Gauge. | | Approximate Equivalent Rainfall. | | With a 8-in. Rain-Gauge. | |
|---|---|---|---|---|---|
| Fluid Ounce Measure. | Cubic Centimetre Measure. | Inches. | Millimetres. | Fluid Ounce Measure | Cubic Centimetre Measure. |
| M 30 | 1 | 0.004† | †0 1 | 1 dram | 3.5 |
| 1 dr. | 3.5 | 0.01 | 0.24 | 2 dr. | 8 |
| 1¼ dr. | 4 | 0.012 | 0.25 | 3 dr. | 10 |
| 1½ dr. | 5 | 0.016 | 0.41 | 4 dr. | 13.5 |
| 1¾ dr. | 6 | 0.018 | 0.45 | 4½ dr. | 15 |
| 2 dr. | 7 | 0.022 ‡ | ‡ 0.55 | 5 dr. | 18 |
| 2¼ dr. | 8 | 0.025 | 0.63 | 6 dr. | 20.5 |
| 2½ dr. | 9 | 0.028 | 0.7 | 6½ dr. | 23 |
| 2¾ dr. | 10 | 0.03 | 0.75 | 7 dr. | 25 |
| 3 dr. | 11 | 0.034 | 0.85 | 1 fl. oz. | 28.4 |
| 3½ dr. | 13 | 0.04 | 1.0 | 9 dr. | 32 |
| 4 dr. | 14 | 0.044 | 1.1 | 10 dr. | 37 |
| 4¼ dr. | 15 | 0.048 | 1.2 | 11 dr. | 40 |
| 4½ dr. | 16.5 | 0.051 | 1.3 | 1½ fl. oz. | 42 |
| 5 dr. | 18 | 0.056 | 1.4 | 13 dr. | 46 |
| 5¾ dr. | 20 | 0.61 | 1.5 | 14 dr. | 50 |
| 6 dr. | 21 | 0.065 § | § 1.6 | 15 dr. | 53 |
| 6½ dr. | 23 | 0.07 | 1.8 | 2 fl. oz. | 56.5 |
| 7 dr. | 24 | 0.075 | 1.9 | 17 dr. | 60 |
| 1 fl. oz. | 28.4 | 0.087 | 2.0 | 2½ fl. oz. | 71.5 |
| 8½ dr. | 30 | 0.098 | 2.4 | 22 dr. | 80 |
| 9 dr. | 33 | 0.1 | 2.5 | 23 dr. | 84 |
| 1¼ fl. oz. | 35 | 0.105 | 2.6 | 3 fl. oz. | 90 |
| 10½ dr. | 39 | 0.12 | 3.0 | 3½ fl. oz. | 99 |
| 11 dr. | 40 | 0.125 | 3.1 | 3¾ fl. oz. | 100 |
| 1½ fl. oz. | 42.5 | 0.13 | 3.3 | 4 fl. oz. | 106 |
| 2 fl. oz. | 56 | 0.17 | 4.4 | 5 fl. oz. | 137 |
| 17 dr. | 60 | 0.18 | 4.6 | 5¼ fl. oz. | 150 |
| 2¼ fl. oz. | 65 | 0.20 | 5.0 | 5½ fl. oz. | 163 |
| 2½ fl. oz. | 71 | 0.22 | 5.5 | 6 fl. oz. | 184 |
| 2¾ fl. oz. | 80 | 0.24 | 6.0 | 7 fl. oz. | 200 |
| 3 fl. oz. | 85 | 0.26 | 6.6 | 8 fl. oz. | 212 |
| 3¼ fl. oz. | 95 | 0.30 | 7.6 | 9 fl. oz. | 240 |
| 3½ fl. oz. | 100 | 0.31 | 7.7 | 9½ fl. oz. | 250 |
| 4 fl. oz. | 112 | 0.35 | 9.0 | 10 fl. oz. | 280 |
| 4¼ fl. oz. | 119 | 0.37 | 9.2 | 10½ fl. oz. | 300 |
| 4½ fl. oz. | 126 | 0.39 | 9.5 | 11 fl. oz. | 325 |
| 4¾ oz. | 133 | 0.40 | 10.0 | 12 oz. | 330 |
| 5 oz. | 140 | 0.44 | 11.0 | 13 oz. | 350 |
| 5½ fl. oz. | 150 | 0.49 | 12.3 | 14 fl. oz. | 400 |
| 5¾ fl. oz. | 159 | 0.50 | 12.7 | 15 fl. oz. | 425 |
| 6 fl. oz. | 168 | 0.53 | 13.2 | 16 fl. oz. | 437 |
| 6¼ fl. oz. | 175 | 0.55 | 13.8 | 16½ fl. oz. | 450 |
| 6½ fl. oz. | 182 | 0.57 | 14.3 | 17 fl. oz. | 475 |
| 53 dr. | 188 | 0.60 | 15.2 | 18 fl. oz. | 490 |
| 6¾ fl. oz. | 190 | 0.61 | 15.3 | 18½ fl. oz. | 500 |
| 7 fl. oz. | 196 | 0.62 | 15.4 | 19 fl. oz. | 510 |
| 7¼ fl. oz. | 200 | 0.63 | 15.5 | 19¼ fl. oz. | 520 |
| 7½ fl. oz. | 208 | 0.66 | 16.5 | 19½ fl. oz. | 545 |

* The Malayan Agricultural and Horticultural Association Magazine—January, 1934. † Mark as: " A trace ".
‡ Slight Precipitation. § " If more than the above, is 'wet day'."

Emergency Table for Estimating Rainfall when the Rain-gauge Gauge-glass is Mislaid or Broken—*continued.*

| With a 5-in. Rain-Gauge. | | Approximate Equivalent Rainfall. | | With an 8-in. Rain-Gauge. | |
|---|---|---|---|---|---|
| Fluid Ounce Measure. | Cubic Centimetre Measure. | Inches. | Millimetres. | Fluid Ounce Measure. | Cubic Centimetre Measure. |
| 7¾ fl. oz. | 210 | 0.67 | 17.0 | 19¾ fl. oz. | 550 |
| 8 fl. oz. | 224 | 0.70 | 17.8 | 1 pint | 575 |
| 8¼ fl. oz. | 230 | 0.74 | 18.5 | 21 fl. oz. | 600 |
| 8½ fl. oz. | 238 | 0.75 | 19.0 | 22 fl. oz. | 625 |
| 9 fl. oz. | 250 | 0.80 | 20.0 | 23½ fl. oz. | 650 |
| 9½ fl. oz. | 262 | 0.84 | 21.0 | 24¾ fl. oz. | 675 |
| 10 fl. oz. | 275 | 0.86 | 21.5 | 26 fl. oz. | 700 |
| 10½ fl. oz. | 287 | 0.90 | 22.9 | 27 fl. oz. | 750 |
| 11 fl. oz. | 300 | 0.98 | 24.5 | 28 fl. oz. | 800 |
| 11¼ fl. oz. | 307 | 1.00 | 25.4 | 29 fl. oz. | 825 |
| 11½ fl. oz. | 325 | 1.05 | 26.5 | 30 fl. oz. | 850 |
| 12 fl. oz. | 350 | 1.10 | 27.6 | 33 fl. oz. | 900 |
| 13 oz. | 375 | 1.17 | 29.0 | 35 oz. | 950 |
| 14 oz. | 400 | 1.25 | 31.0 | 37 oz. | 1 litre |
| 15 fl. oz. | 450 | 1.39 | 34.9 | 2 pints (1 quart) | 1146 |
| 17½ fl. oz. | 500 | 1.50 | 38.1 | 45 fl. oz. | 1315 |
| 1 pint | 550 | 1.76 | 44.1 | 2½ pints | 1400 |
| 21 fl. oz. | 600 | 1.86 | 46.6 | 55 fl. oz. | 1½ litres |
| 23 fl. oz. | 650 | 2.00 | 50.8 | 3 pints | 1700 |
| 25 fl. oz. | 700 | 2.17 | 54.4 | 70 fl. oz. | 1800 |
| 28 fl. oz. | 800 | 2.48 | 62.2 | 75 fl. oz. | 2 litres |
| 30 fl. oz. | 850 | 2.50 | 63.5 | 77 fl. oz. | 2010 |
| 32 fl. oz. | 900 | 2.78 | 69.7 | 4 pints | 2200 |
| 25 fl. oz. | 1 litre | 3.00 | 76.2 | 90 fl. oz. | 2500 |
| 2 pints (= 1 quart) | 1100 | 3.25 | 87.8 | 5 pints | 2750 |
| 45 fl. oz. | 1200 | 3.50 | 88.9 | 110 fl. oz. | 3 litres |
| 47 fl. oz. | 1290 | 3.75 | 95.2 | 120 fl. oz. | 3250 |
| 2½ pints | 1375 | 4.00 | 101.6 | 130 fl. oz. | 3500 |
| 54 fl. oz. | 1445 | 4.25 | 107.9 | 135 fl. oz. | 3700 |
| 55½ fl. oz. | 1510 | 4.50 | 114.3 | 140 fl. oz. | 3800 |
| 57 fl. oz. | 1580 | 4.75 | 120.6 | 145 fl. oz. | 3900 |
| 3 pints | 1650 | 5.00 | 127.0 | 150 fl. oz. | 4 litres |
| 3¼ pints | 1790 | 5.25 | 133.3 | 155 fl. oz. | 4250 |
| 67 fl. oz. | 1895 | 5.50 | 139.7 | 1 gal. (= 8 pints) | 4500 |
| 3½ pints | 2 litres | 5.75 | 146.0 | 175 fl. oz. | 4700 |
| 72 fl. oz. | 2040 | 6.00 | 152.4 | 180 fl. oz. | 4900 |
| 75 fl. oz. | 2080 | 6.25 | 158.7 | 185 fl. oz. | 5 litres |
| 77 fl. oz. | 2120 | 6.50 | 165.1 | 192 fl. oz. | 5200 |
| 78½ oz. | 2160 | 6.75 | 171.4 | 200 oz. | 5400 |
| 4 pints | 2200 | 7.00 | 177.8 | 207 oz. | 5600 |

Emergency Table for Estimating Rainfall when the Rain-gauge Gauge-glass is Mislaid or Broken—*continued*.

| With a 5-in. Rain-Gauge. | | Approximate Equivalent Rainfall. | | With an 8-in. Rain-Gauge. | |
|---|---|---|---|---|---|
| Fluid Ounce Measure. | Cubic Centimetre Measure. | Inches. | Millimetres. | Fluid Ounce Measure. | Cubic Centimetre Measure. |
| 82 fl. oz. | 2240 | 7.25 | 184.1 | 215 fl. oz. | 5800 |
| 85 fl. oz. | 2280 | 7.5 | 190.5 | 220 fl. oz. | 6 litres |
| 87½ fl. oz. | 2320 | 7.75 | 196.8 | 225 fl. oz. | 6200 |
| 4½ pints | 2360 | 8.00 | 203.2 | 240 fl. oz. | 6400 |
| 95 fl. oz. | 2440 | 8.50 | 215.9 | 250 fl. oz. | 6800 |
| 97 fl. oz. | 2480 | 8.75 | 222.2 | 260 fl. oz. | 7 litres |

The average rainfall in various parts of the world differs considerably, for instance, in the British Isles, the average annual rainfall for England is 37.4 inches, but in Styhead, Cumberland, a rainfall of 247.3 inches was recorded in 1923. The wettest station in the world is Cherrapunji in Assam, where the annual fall exceeds 500 inches, and the daily fall has reached 40 inches, whilst in one year just over 900 inches is alleged to have fallen. For New Guinea the record rainfall was registered at Pal Mal Mal in the Jaquenot Bay district in New Britain, viz., 320.12 inches, although it should be noted that in 1934 the rainfall for this particular station was 166.64 inches, while in 1936, 213.36 inches were recorded. In 1927 Talasea Government station recorded 312 inches. The lowest rainfall for the Territory is at our inland stations, Ramu 78.57 inches, Bulolo (six years) 55.06 inches, Baiune 65.90 inches (three years).

Plantation managers and private individuals have assisted considerably in the supply of rainfall information and returns, and it is hoped they will continue to do so. Additional rainfall records are also desirable from other stations, and persons interested who may care to supply such information, will be assisting in a great service towards acquiring essential data concerning the general potential knowledge of this territory. Rainfall records are really invaluable to all agriculturists and horticulturists. They will determine the best time to plant, the type of crops to plant, and the most favorable season to produce the best germination. The expense of installing a rain gauge will be found small, and the illuminating results will well repay the observer, and even if instruments are not available, a diary kept of the weather will be found of great interest over an extended period, and throw light on crop failures or successes, activities of pests and diseases, results of spraying, &c.

It may be of interest to quote the following table showing the rainfall and temperatures of various world cities:—

RAINFALL AND TEMPERATURES—VARIOUS CITIES.

| Place. | Annual Rainfall. | | | | Temperature. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Height above M.S.L. | Average. | Highest. | Lowest. | (a) Mean Summer. | (b) Mean Winter. | Highest on Record. | Lowest on Record. | Average Hottest Month. | Average Coldest Month. |
| | Ft. | In. | In. | In. | Fahr. | Fahr. | Fahr. | Fahr. | Fahr. | Fahr. |
| Adelaide .. | 140 | 21.17 | 30.87 | 11.39 | 72.9 | 53.1 | 116.3 | 32.0 | 74.0 | 51.9 |
| Berlin .. | 161 | 22.72 | 30.04 | 14.25 | 64.8 | 33.0 | 98.6 | −13.4 | 66.0 | 31.8 |
| Bombay .. | 32 | 70.54 | 114.89 | 33.42 | 82.7 | 74.7 | 100.2 | 53.2 | 84.3 | 73.9 |
| Brisbane .. | 137 | 45.31 | 88.26 | 16.17 | 76.7 | 59.8 | 108.9 | 36.1 | 77.2 | 58.6 |
| Calcutta .. | 21 | 61.82 | 98.48 | 38.43 | 85.6 | 68.0 | 111.3 | 44.2 | 86.0 | 66.4 |
| Canberra .. | 1,920 | 23.03 | 33.71 | 16.31 | 67.7 | 43.9 | 104.2 | 14.0 | 68.6 | 42.8 |
| Colombo .. | 24 | 88.53 | 123.96 | 53.56 | 81.6 | 78.7 | 97.2 | 61.6 | 82.0 | 78.6 |
| Hobart .. | 177 | 24.06 | 43.39 | 13.43 | 61.4 | 46.9 | 105.2 | 27.0 | 62.2 | 45.8 |
| Hong Kong .. | 109 | 85.61 | 119.72 | 45.84 | 81.5 | 60.5 | 97.0 | 32.0 | 82.0 | 58.8 |
| Johannesburg | 5,750 | 31.63 | 50.00 | 21.66 | 65.4 | 54.4 | 93.6 | 20.8 | 68.2 | 48.0 |
| London .. | 18 | 23.80 | 38.18 | 12.16 | 60.8 | 39.9 | 94.0 | 9.0 | 62.3 | 39.1 |
| Madras .. | 22 | 49.85 | 78.92 | 21.74 | 89.0 | 76.8 | 113.0 | 57.5 | 89.9 | 76.1 |
| Madrid .. | 2,149 | 16.23 | 27.48 | 9.13 | 73.0 | 41.2 | 107.1 | 10.5 | 75.7 | 39.7 |
| Melbourne .. | 115 | 25.72 | 38.04 | 15.61 | 66.6 | 50.1 | 111.2 | 27.0 | 67.6 | 48.8 |
| New York .. | 314 | 44.63 | 58.68 | 33.17 | 71.4 | 31.8 | 102.0 | −13.0 | 73.5 | 30.2 |
| Paris .. | 164 | 22.68 | 29.80 | 10.94 | 63.5 | 37.9 | 101.1 | −19.5 | 64.8 | 36.7 |
| Rome .. | 166 | 32.57 | 57.89 | 12.72 | 74.3 | 46.0 | 103.0 | 21.4 | 76.1 | 44.6 |
| Shanghai .. | 21 | 45.00 | 62.52 | 27.92 | 78.0 | 41.1 | 102.9 | 10.2 | 80.4 | 37.8 |
| Singapore .. | 8 | 91.99 | 158.68 | 32.71 | 81.2 | 78.6 | 94.2 | 63.4 | 81.5 | 78.3 |
| Sydney .. | 138 | 47.32 | 82.76 | 23.01 | 70.9 | 54.3 | 108.5 | 35.7 | 71.6 | 53.0 |

## Meteorological Records—Madang.

*(New Guinea Central.)*

The driest month in the Madang district is August, and the wettest April. The rainy season is practically continuous from October to May, and the dry season a short one during July, August and September. There are, however, parts of this district which have a considerably longer dry season.

The district immediately north of Madang—Sepik—has a similar dry season, though it continues comparatively dry for two months longer; nor are the monsoonal rains so heavy when experienced.

The rainfall in Madang for April is the heaviest recorded on the mainland of New Guinea, and is exceeded in few districts in the Territory. December is also an exceedingly wet month in this district.

On the coastline of Madang, recent deposits of coral limestone may be seen from the head of Astrolabe Bay to Stephen Strait. All the islands about Madang and Sek (Alexishafen) consist of it. The limestones do not extend very far inland, and cannot be more than 50 feet thick. It rests on some recent volcanic rocks near Isumrud Strait, and is frequently interbedded with friable volcanic material. Beyond Stephen Strait the deltaic deposits of the Sepik and Ramu rivers have prohibited the growth of coral reefs, even as far back as early Pleistocene, and consequently no occurrences of limestone are seen. Again, at Melamu (Konstantine Harbour), large deposits of boulders and river gravels have invaded the coral strands, the Kabenau and Minjem rivers being responsible for the denudation of the thin veneer of coral limestone replacing it with river sediment during the process of elevation.

On the coastline between Sarang and Dylup plantations the raised coral reefs are interbedded with coarse, partly fossiliferous grits and conglomerates containing magnetite sand occasionally cemented with lime. The limestone outcrop on the plantation of Dylup occasionally exhibits a peculiar banded or striated structure not unlike phosphatic rock.

The soil around the foreshore of Madang is a sandy coral loam; pure coral being met at depths ranging from less than 1 foot to 2½ feet.

Towards the back of Modilon, the adjoining plantation, the soil is a heavier volcanic nature with coral outcrops and a clayey sub-soil.

Madang experiences many thunderstorms, and the tall trees are often affected by the visitations of lightning strike.

The only other stations in this district from which official records are received, are Kulili and Kurum on Kar Kar Island. The department would welcome rainfall records from additional plantations on the mainland.

MONTHLY AND YEARLY RAINFALL TOTALS (IN POINTS), MADANG.

| Year. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Yearly Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1917 .. | 1,379 | 1,015 | 1,745 | 1,284 | 1,999 | 1,212 | 928 | 671 | 1,255 | 1,755 | 1,491 | 693 | 15,427 |
| 1918 .. | 617 | 1,131 | 1,269 | 1,007 | 1,654 | 625 | 447 | 311 | 428 | 1,209 | 642 | 441 | 9,781 |
| 1919 .. | 1,250 | 2,424 | 2,792 | 2,449 | 1,679 | 1,607 | 165 | 3 | 133 | 795 | 1,484 | 1,749 | 16,530 |
| 1920 .. | 1,362 | 1,004 | 2,583 | 1,218 | 1,725 | 1,333 | 553 | 207 | 912 | 2,074 | 1,400 | 1,660 | 16,031 |
| 1921 .. | 1,804 | 947 | 831 | 3,120 | 965 | 1,313 | 1,446 | 310 | 539 | 862 | 1,777 | 1,360 | 15,274 |
| 1922 .. | 1,569 | 1,219 | 1,407 | 2,085 | 785 | 872 | 451 | 598 | 524 | 1,098 | 1,357 | * | * |
| 1923 .. | 384 | 1,687 | 1,682 | 1,284 | 2,444 | 2,765 | 579 | 307 | 86 | 738 | 1,666 | 696 | 14,318 |
| 1924 .. | 1,324 | 654 | 1,217 | 1,007 | 1,549 | 879 | 461 | * | * | * | 1,637 | 607 | * |
| 1925 .. | 10 | 482 | 495 | 1,164 | 703 | 1,246 | 963 | 129 | 370 | 373 | 1,644 | 765 | 8,344 |
| 1926 .. | 2,120 | 1,498 | 1,533 | 1,700 | 2,247 | 1,135 | 598 | 53 | 175 | 1,085 | 803 | 1,747 | 14,694 |
| 1927 .. | 701 | 744 | 1,057 | 1,077 | 1,523 | 1,285 | 501 | 782 | 472 | 616 | 1,042 | 3,180 | 12,980 |
| 1928 .. | 1,316 | 1,283 | 955 | 2,177 | 2,033 | 920 | 449 | 762 | 720 | 1,911 | 1,277 | 1,013 | 14,816 |
| 1929 .. | 1,200 | 930 | 1,009 | 1,973 | 2,004 | 856 | 1,108 | 1,152 | 169 | 1,041 | 1,158 | 1,506 | 14,108 |
| 1930 .. | 861 | 1,146 | 2,089 | 2,562 | 1,581 | 761 | 1,577 | 268 | 6 | 297 | 1,208 | 1,782 | 14,136 |
| 1931 .. | 1,023 | 962 | 2,083 | 1,896 | 737 | 274 | 309 | 275 | 125 | 802 | 981 | 1,890 | 11,357 |
| 1932 .. | 1,895 | 1,245 | 693 | 1,404 | 722 | 1,247 | 685 | 141 | 489 | 348 | 1,721 | 1,189 | 11,779 |
| 1933 .. | 1,815 | 1,296 | 1,617 | 1,081 | 1,112 | 1,088 | 1,279 | 394 | 1,129 | 1,173 | 756 | 2,104 | 14,844 |
| 1934 .. | 334 | 560 | 794 | 1,358 | 677 | 1,124 | 1,234 | 300 | 712 | 930 | 1,277 | 814 | 10,114 |
| 1935 .. | 2,127 | 1,267 | 1,226 | 3,047 | 2,523 | 579 | 617 | 610 | 819 | 586 | 1,377 | 550 | 15,328 |
| 1936 .. | 1,136 | 1,366 | 1,871 | 479 | 1,677 | 370 | 925 | 1,495 | 786 | 729 | 2,085 | 2,483 | 15,402 |
| Average .. | 1,211 | 1,143 | 1,447 | 1,669 | 1,517 | 1,075 | 764 | 461 | 518 | 970 | 1,339 | 1,380 | 13,626 |

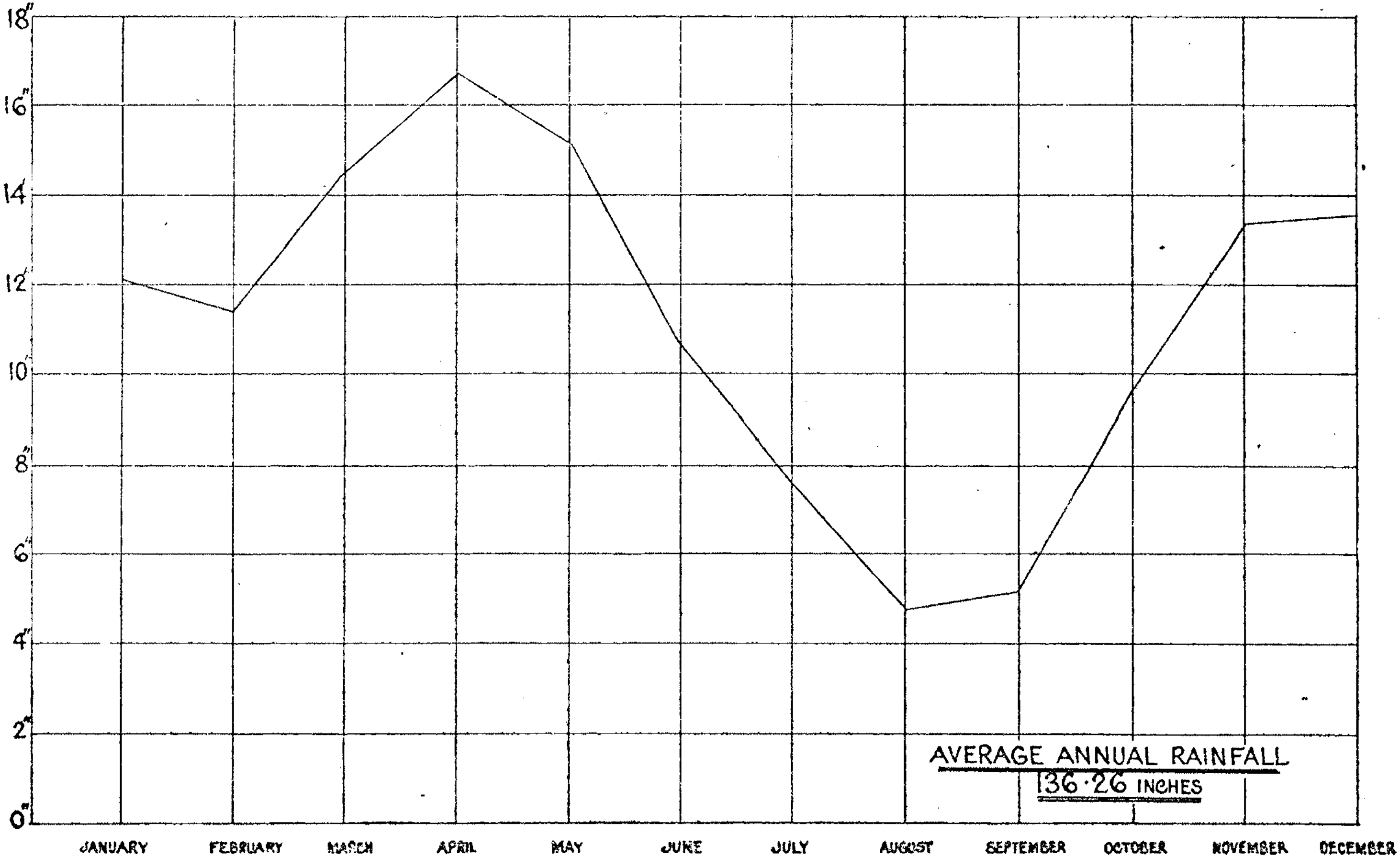
* No records taken during these months.

MADANG (MAINLAND), 5° 11′ S., 145° 48′ E.

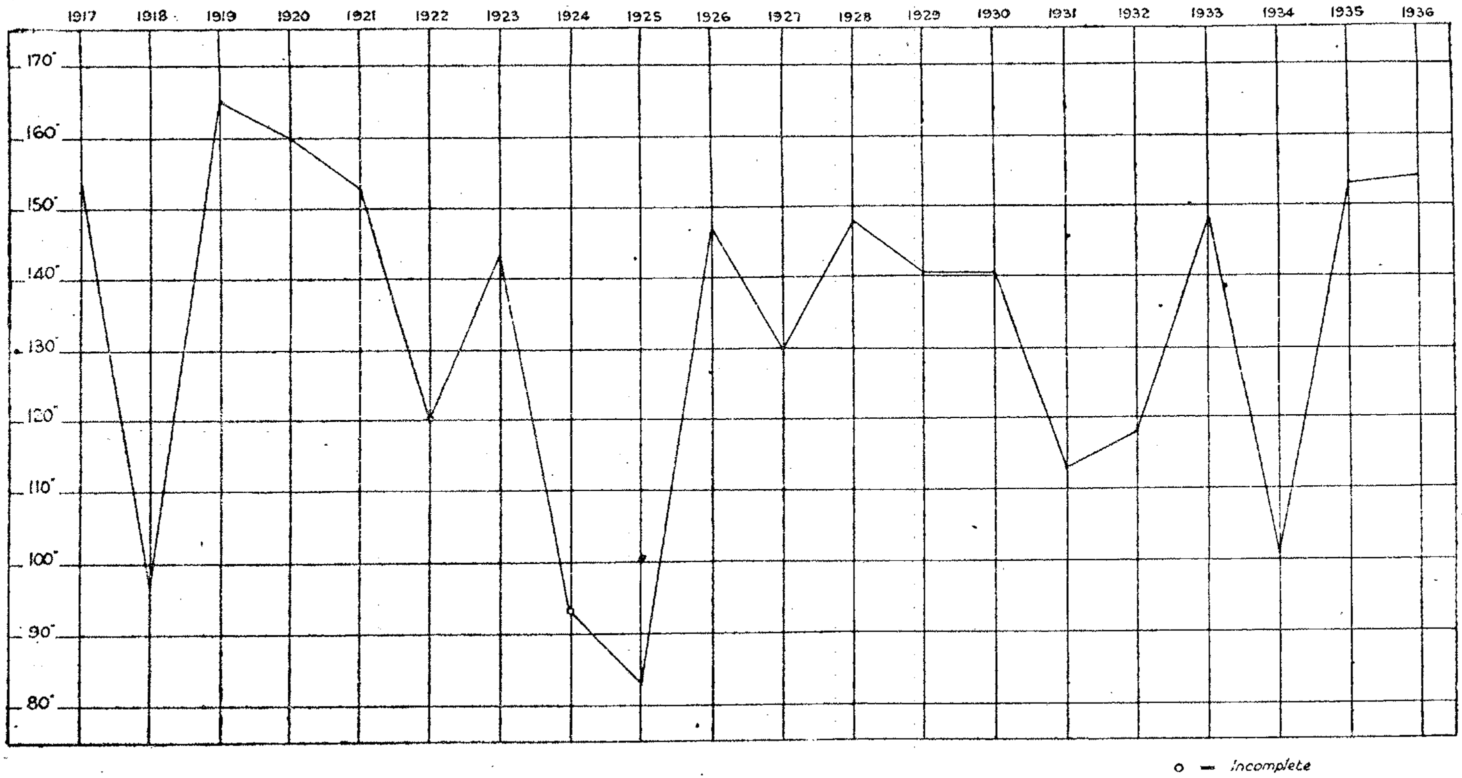
| Month. | 1936. | | Averages for 20 years (1917–1936). | |
|---|---|---|---|---|
| | Rainfall. | Wet Days. | Rainfall. | Wet Days. |
| January .. .. .. | 11.36 | 23 | 12.11 | 19.4 |
| February .. .. .. | 13.66 | 19 | 11.43 | 17.8 |
| March .. .. .. | 18.71 | 22 | 14.47 | 20.7 |
| April .. .. .. | 4.79 | 12 | 16.69 | 20.4 |
| May .. .. .. | 16.77 | 25 | 15.17 | 19.4 |
| June .. .. .. | 3.70 | 14 | 10.75 | 17.3 |
| July .. .. .. | 9.25 | 15 | 7.64 | 14.0 |
| August .. .. .. | 14.95 | 17 | 4.61 | 9.0 |
| September .. .. .. | 7.86 | 15 | 5.18 | 14.2 |
| October .. .. .. | 7.29 | 15 | 9.70 | 13.2 |
| November .. .. .. | 20.85 | 27 | 13.39 | 16.3 |
| December .. .. .. | 24.83 | 21 | 13.80 | 19.5 |

Rainfall for 1936—154.02 inches. Rainfall average for 20 years—136.26 inches.

GRAPH SHOWING MONTHLY AVERAGES RAINFALL 1917-1936 (20 YEARS) FOR MADANG, TERRITORY OF NEW GUINEA.



GRAPH SHOWING ANNUAL RAINFALL FOR MADANG, TERRITORY OF NEW GUINEA.



## KULILI PLANTATION (KAR KAR ISLAND)—MADANG DISTRICT.

| Month. | 1936. | | Averages for Two Years. | |
|---|---|---|---|---|
| | Rainfall. | Wet Days. | Rainfall. | Wet Days. |
| January .. .. .. | 14.43 | 28 | 14.43 | 25.5 |
| February .. .. .. | 14.60 | 24 | 14.60 | 22.0 |
| March .. .. .. | 14.05 | 17 | 17.73 | 14.5 |
| April .. .. .. | 10.76 | 19 | 11.09 | 19.0 |
| May .. .. .. | 9.66 | 17 | 11.33 | 20.0 |
| June .. .. .. | 8.10 | 13 | 6.52 | 14.0 |
| July .. .. .. | 5.71 | 18 | 4.83 | 14.5 |
| August .. .. .. | 9.05 | 20 | 6.41 | 16.0 |
| September .. .. .. | 4.93 | 18 | 6.33 | 17.0 |
| October .. .. .. | 14.02 | 22 | 12.97 | 21.0 |
| November .. .. .. | 20.14 | 20 | 23.38 | 21.5 |
| December .. .. .. | 21.29 | 18 | 16.51 | 16.5 |

Total rainfall for 1936—146.74 inches. Annual average for 2 years—146.13 inches.

## KURUM (KAR KAR ISLAND)—MADANG DISTRICT.

### LUTHERAN MISSION STATION.

| Month. | 1936. | | Averages for Thirteen Years. | |
|---|---|---|---|---|
| | Rainfall. | Wet Days. | Rainfall. | Wet Days. |
| January .. .. .. | 22.90 | 17 | 11.08 | 17.5 |
| February .. .. .. | 9.10 | 13 | 10.77 | 16.2 |
| March .. .. .. | 11.74 | 13 | 12.13 | 17.6 |
| April .. .. .. | 7.73 | 9 | 10.48 | 17.6 |
| May .. .. .. | 9.90 | 7 | 11.88 | 17.4 |
| June .. .. .. | 4.25 | 8 | 7.83 | 15.8 |
| July .. .. .. | 6.37 | 11 | 6.65 | 12.9 |
| August .. .. .. | 11.60 | 14 | 6.82 | 12.4 |
| September .. .. .. | 6.42 | 16 | 6.23 | 12.6 |
| October .. .. .. | 15.35 | 19 | 11.25 | 15.8 |
| November .. .. .. | 9.61 | 23 | 9.65 | 16.0 |
| December .. .. .. | 19.44 | 19 | 10.30 | 15.8 |

Rainfall for 1936—134.41 inches. Annual average for 13 years—115.07 inches.

# TANGLEFOOT BANDING OF COCO-NUT PALMS AGAINST *SEXAVA*.

*By John L. Froggat, B.Sc., Entomologist.*

In preparing a scheme of investigations into the *Sexava* problem, every possible avenue of attack had to be considered. In view of the fact that the eggs are deposited mainly in the soil, and the nymphs have to ascend the palms, experimental trials with tanglefoot banding of the palms appeared to be well worth carrying out to determine what results could be obtained in destroying the young hoppers before they could reach the head of the palm.

Such trials were first carried out on Pak Plantation, Manus, with a mixture having a resin base. The results demonstrated that large numbers of first, and to a lesser degree second, stage nymphs were caught in the bands and destroyed; a few were found to cross the obstruction, but their movements showed that a sufficient amount of the mixture adhered to their "feet" as to hamper their movements and render them an easy prey to ants, &c. These tests were carried out by Mr. N. E. H. Caldwell, B.Sc., Assistant Entomologist.

Further trials were later carried out on Mokareng Plantation, Manus, but the pressure of the parasite breeding and liberation forced this line of work into abeyance for the time being.

In January-February, 1937, Mr. B. A. O'Connor, B.Sc.Agr., Assistant Entomologist, laid out two plots side by side for comparative testing of two types of tree-tanglefoot, the one with a resin base, the same as that used in previous trials, the other with a waxy base. Although the question of damage to the palm by the direct application of the resin-base mixture on to the trunk did not arise in this case, it is a matter of considerable importance with soft-barked trees; the waxy base material has been developed to eliminate this danger, and samples were given to the Entomologist by the English manufacturers while in England on leave in 1936.

These plots were in a moderately infested area of palms, and lay in the direction in which dispersion would probably take place.

Due, possibly, to climatological conditions, the waxy-base material, although yielding good catches for about two weeks, steadily deteriorated, and became useless in a very short time. This matter has been taken up with the manufacturers, who advise that they will endeavour to prepare a material that will stand up to the exacting conditions experienced (*vide* Graph No. 2).

On the other hand, the resin-base material gave good results for about two and a half months, and remained tacky and operative in a lesser degree for four months.

A peculiar feature in these trials was the attack by wild bees on the waxy-base material about two weeks after the inception of the trials; two bands were completely denuded within a week, and others were removed later. After the waxy-base bands had been severely affected, the bees began to remove the resin-base material.

The results for the first eleven weeks showed a marked and more or less regular fluctuation in the numbers caught, particularly noticeable when the counts per row per week are examined (*vide* Graph No. 1), but we were not able to definitely link this with variations in the emergence of *Sexava* nymphs.

The variation in the numbers caught on even adjacent palms was very great, even from day to day; this was also noted in the case of individual palms; some palms yielded consistently higher catches than others. The counts per palm per week to 1st April are shown in the appended table.

On some occasions, for unavoidable reasons counts were made at two, and occasionally three, day intervals, and it was noticeable that on these occasions there were remains of nymphs, such as one leg, showing that some of those caught on the bands had been removed by predators such as small lizards and ants. These were counted as well as possible but some may have been removed completely, and were not countable. There is, therefore, evidence to show that although the counts made represent the majority of the nymphs caught, they do not represent the absolute total, as there was an indeterminable number that could not be included.

Older nymphs than those referred to and adult *Sexava* were able to cross a 6-inch band, but in the process they collected a certain amount of material on the tarsi (or feet) which would possibly lead to their being attacked more easily by lizards, &c.

Bands of different widths were used, but it was found that any under 4½ inches were not satisfactory, both in catching and lasting qualities. In practice, the simplest method of application was by hand, this not only being quicker than with a piece of board, but it also gave the approximately correct width.

One pound of this material is sufficient to treat five palms, so that 1 cwt. should be sufficient to treat over 500 palms; the rate at which it can be applied depends very greatly on the celerity of the operator. We have received advice that this material can be supplied from England at 100s. (sterling) per cwt. in cwt. lots.

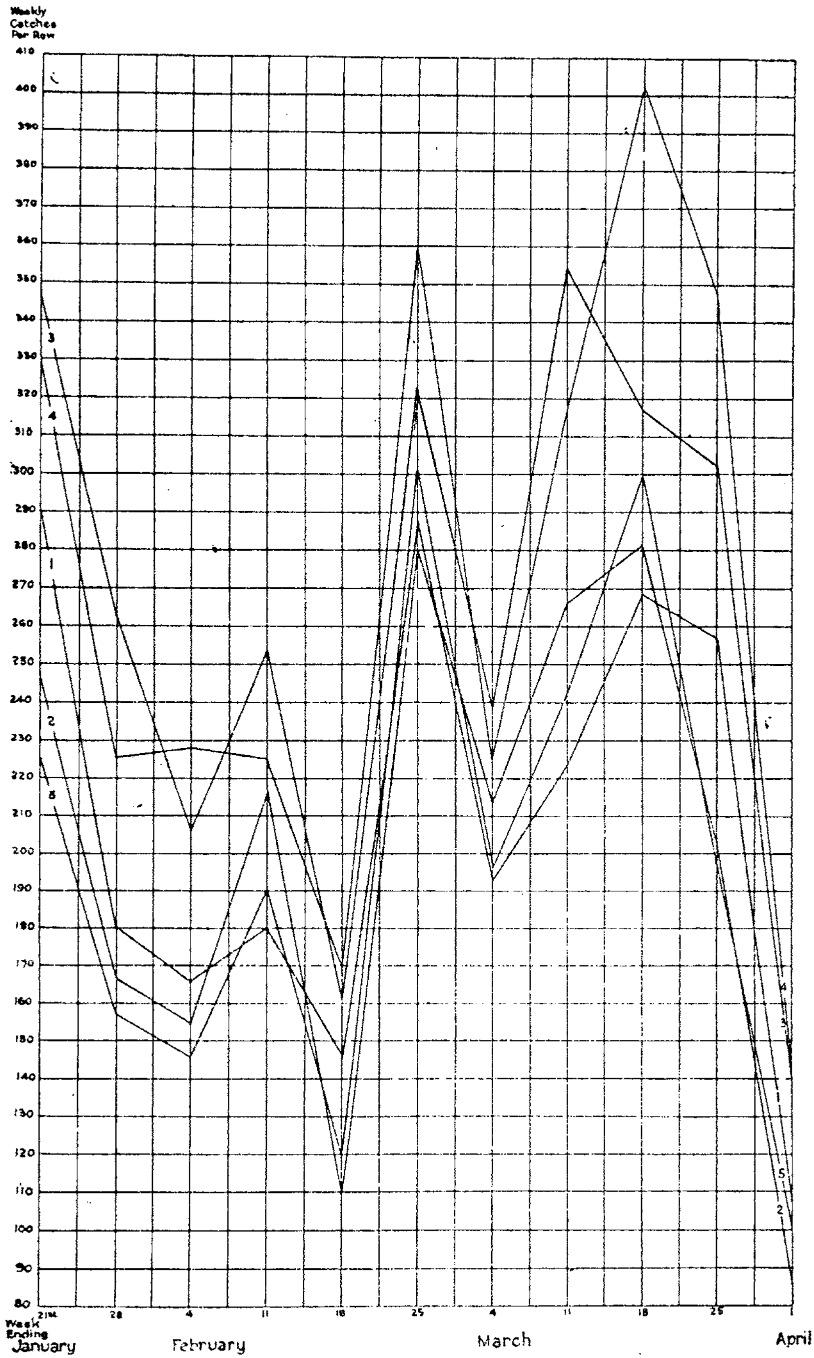
It seems possible that in the early stages of infestation, when the hopper is relatively localized, this method might be used with considerable benefit in reducing population of the early stages before the nymphs can reach the head of the palms.

## TANGLEFOOT BANDING (RESIN BASE).

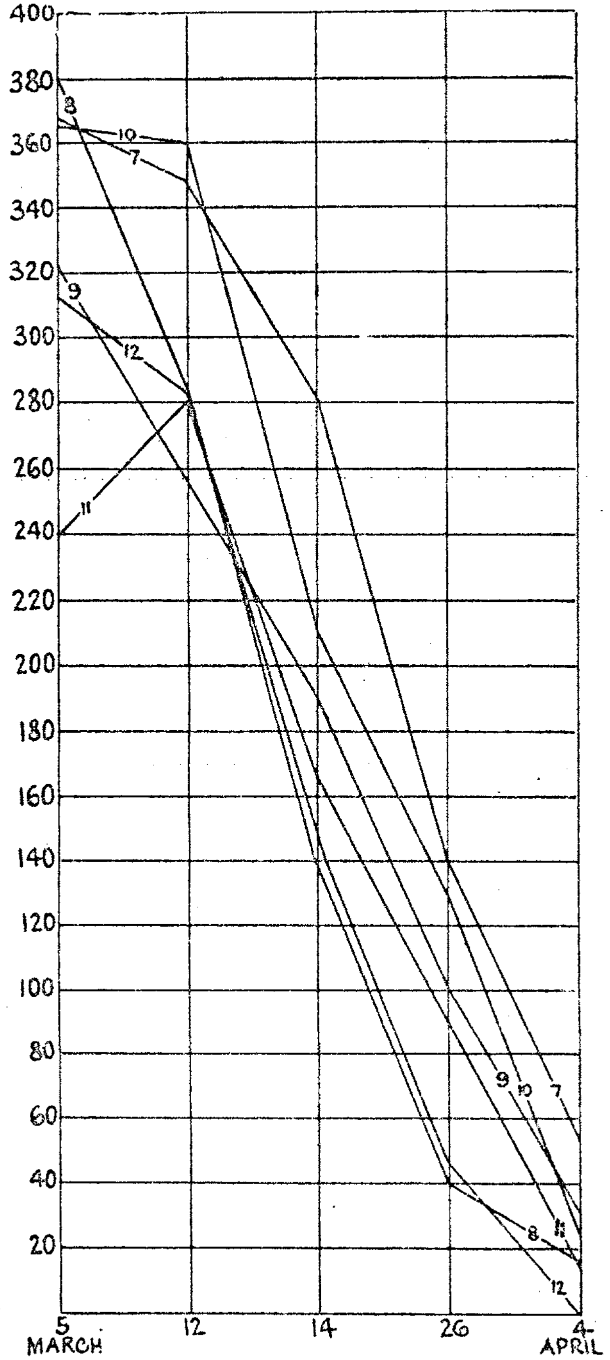
Weekly catches per palm, Nos. 1–30.

| Palm No. | For Week Ending— | | | | | | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | January. | | February. | | | | March. | | | | April. | |
| | 21. | 28. | 4. | 11. | 18. | 25. | 4. | 11. | 18. | 25. | 1. | |
| 1 .. | 15 | 10 | 6 | 11 | 10 | 18 | 18 | 23 | 14 | 19 | 7 | 151 |
| 2 .. | 32 | 28 | 29 | 21 | 15 | 39 | 30 | 21 | 40 | 37 | 31 | 323 |
| 3 .. | 59 | 44 | 47 | 70 | 52 | 94 | 48 | 54 | 58 | 82 | 42 | 680 |
| 4 .. | 53 | 25 | 21 | 20 | 21 | 47 | 35 | 52 | 56 | 54 | 23 | 407 |
| 5 .. | 91 | 47 | 29 | 26 | 30 | 63 | 39 | 42 | 47 | 30 | 19 | 464 |
| 6 .. | 42 | 27 | 34 | 32 | 19 | 27 | 23 | 39 | 63 | 36 | 14 | 346 |
| 7 .. | 34 | 35 | 28 | 21 | 13 | 25 | 27 | 28 | 34 | 28 | 21 | 294 |
| 8 .. | 33 | 24 | 23 | 42 | 10 | 42 | 29 | 31 | 31 | 19 | 13 | 277 |
| 9 .. | 67 | 33 | 29 | 60 | 33 | 72 | 39 | 45 | 38 | 28 | 12 | 456 |
| 10 .. | 32 | 13 | 11 | 14 | 16 | 21 | 10 | 31 | 49 | 27 | 9 | 233 |
| 11 .. | 37 | 30 | 22 | 26 | 24 | 57 | 52 | 62 | 57 | 49 | 24 | 440 |
| 12 .. | 45 | 32 | 42 | 37 | 14 | 62 | 57 | 70 | 74 | 55 | 24 | 512 |
| 13 .. | 55 | 51 | 32 | 26 | 23 | 31 | 27 | 27 | 44 | 38 | 9 | 363 |
| 14 .. | 48 | 33 | 20 | 30 | 20 | 43 | 26 | 53 | 37 | 23 | 13 | 346 |
| 15 .. | 55 | 34 | 30 | 32 | 28 | 56 | 46 | 46 | 37 | 49 | 50 | 473 |
| 16 .. | 47 | 31 | 21 | 32 | 15 | 62 | 33 | 54 | 48 | 53 | 31 | 427 |
| 17 .. | 71 | 49 | 55 | 46 | 34 | 61 | 44 | 72 | 66 | 71 | 33 | 592 |
| 18 .. | 69 | 56 | 48 | 51 | 37 | 68 | 62 | 103 | 97 | 69 | 25 | 685 |
| 19 .. | 41 | 13 | 32 | 27 | 22 | 49 | 24 | 45 | 64 | 48 | 19 | 384 |
| 20 .. | 51 | 44 | 26 | 30 | 23 | 54 | 21 | 59 | 60 | 64 | 28 | 440 |
| 21 .. | 69 | 49 | 23 | 18 | 16 | 60 | 29 | 29 | 27 | 37 | 12 | 369 |
| 22 .. | 52 | 38 | 38 | 30 | 33 | 84 | 37 | 49 | 60 | 71 | 37 | 528 |
| 23 .. | 73 | 47 | 60 | 66 | 56 | 53 | 45 | 57 | 78 | 53 | 18 | 606 |
| 24 .. | 50 | 35 | 50 | 40 | 20 | 63 | 61 | 81 | 112 | 73 | 51 | 636 |
| 25 .. | 40 | 24 | 17 | 19 | 19 | 27 | 23 | 27 | 47 | 24 | 9 | 276 |
| 26 .. | 33 | 27 | 13 | 15 | 13 | 36 | 15 | 22 | 23 | 21 | 5 | 223 |
| 27 .. | 16 | 19 | 10 | 15 | 8 | 40 | 28 | 25 | 28 | 29 | 21 | 239 |
| 28 .. | 72 | 58 | 57 | 60 | 34 | 86 | 50 | 62 | 67 | 47 | 25 | 618 |
| 29 .. | 39 | 18 | 29 | 30 | 19 | 46 | 41 | 50 | 52 | 53 | 30 | 406 |
| 30 .. | 21 | 12 | 22 | 39 | 26 | 56 | 43 | 56 | 81 | 27 | 24 | 407 |

# GRAPH No. 1.—TANGLEFOOT BANDING (RESIN BASE)—ROWS 1-5.—NUMBERS CAUGHT PER ROW PER WEEK.



GRAPH No. 2.—TANGLEFOOT BANDING (WAXY BASE).—ROWS 7-12.—
CATCHES PER ROW PER WEEK.



# REPRINT AGRICULTURAL RESEARCH AND DEMONSTRATION IN THE DUTCH EAST INDIES.

*By Leslie C. Coleman, M.A., Ph.D., Director of Agriculture in Mysore, in General Services Bulletin No. 14 of the Department of Agriculture, Mysore State.*

## ORGANIZATION UNDER PRIVATE CONTROL.

. . . a characteristic feature of work concerned with agricultural development in the Netherlands East Indies is the extent to which private organizations of growers (largely Europeans) support agricultural research. This is a feature which should be borne constantly in mind. It is not too much to say that the acknowledged reputation of these colonies for research in tropical agriculture is based largely on the work that has been done on experiment stations supported and controlled by private enterprise. Until comparatively recently, the individual experiment stations were organized and supported by comparatively small organizations of planters formed, either on the basis of crops, or on geographical position. Within the last few years, however, a need for co-ordination of effort has been felt and this has led to the formation of large organizations controlling a number of separate stations. Thus the sugar industry, which formerly had three separate experiment stations controlled by three separate organizations, has now one organization for the control of all its experimental work. Similarly, all the experimental work done in Java on the so-called "mountain cultures" tea, coffee, rubber, and cinchona, which was formerly controlled by a number of different organizations is now under the control of the General Agricultural Syndicate. There are, however, still a number of experiment stations under the control of smaller organizations who have not joined the syndicate. Thus, the experiment station for Vorstenland tobacco at Klaten is supported by a comparatively small group of tobacco companies. The rubber-planters of East Sumatra, and the tobacco-planters of the province of Deli in Sumatra have each their own experiment station. The tobacco companies of Besoeki province (East Java) have retained their independence and partially support the experiment station at Djember in that province where valuable work on the improvement of tobacco is in progress.

# TROPICAL AGRICULTURE THEN AND NOW.*

*By W. G. Freeman, B.Sc., A.R.C.S., F.L.S., Imperial Institute, London, late Director of Agriculture, Trinidad and Tobago.*

. . . our knowledge of scientific tropical agriculture is of quite recent growth. On the other hand what may conveniently be termed the art of agriculture in the tropics as practised by various native races, is based frequently on very long experience and very close observation.

Take with respect to the latter point the discoveries made by native races on the properties of plants. They are indeed remarkable. The modern world uses large quantities of three beverages, tea, coffee and cocoa, the first prepared from leaves the others from seeds, but all alike containing as their essential principle caffeine or a closely similar alkaloid. Two other plants of considerable, but not such wide use for the sake of their stimulating alkaloids are cola (caffeine) and coca (cocaine). In these cases beverages are not prepared, but the seeds or leaves respectively are chewed. The discoveries of the properties of these plants and the methods of utilization were made not only in widely separated parts of the world, tea in Indo-China, cola in tropical Africa, coffee in Arabia, cocoa in Central America and coca in the Andean region, but so long ago that they are lost in the mists of antiquity. What is still more remarkable is that primitive man seems to have conducted his researches so thoroughly that all the resources of science have not as yet discovered any other plants containing important supplies of these alkaloids. I have often wondered when strolling through a tropical forest or through a botanic garden how primitive man made his discoveries, for casually chewing a cola nut or a coca leaf produces no appreciable stimulation. Similarly it would be a piece of very long range research to prepare and test infusions of all the available seeds or leaves.

On a point of agricultural practice too, we know that some tropical crops, e.g., coffee and cacao, are commonly grown under the shade of other trees, the practice having been handed down from remote times. When, by experiment, we endeavour to ascertain whether this is a desirable practice or not, it is very difficult to arrive at a definite conclusion even when we restrict our attention to the use of one particular kind of tree. We might expect that native races in Central America who shade their coffee do so as the result of observation, and that they would use any trees which happen to be available—and they are many. As shown, however, a good many years ago by O. F. Cook this is not so. In different districts they use different trees, but with one thing in common; they practically all belong to the *Leguminosae*. In other words the practice is a form of green manuring applied to permanent crops. These folks have not an ancient literature or we might have the advantage of being able to read their views on the use of these leguminous shade trees set down as precisely as those of the Chinese, the Greeks and the Romans on the green manuring of annual crops.

This extract from p. 10 of Dr. A. J. Pieters' *Green Manuring* must suffice. "In Ts'i Min Yao Shu of Chia Szu Hsieh, who lived about the fifth century B.C., there is a passage which reads: 'For manuring the field, lu tou *(Phaseolus mungo*

* Reprinted from "The Colonial Services Club" Magazine.

L. var. *radiatus Bak.*) is best, and siao tou (*P. mungo* L. var.) and sesame rank second. They are broadcast in the fifth or sixth month, and ploughed under in the seventh or eighth month . . . Their fertilizing value is as good as silk worm excrement and well-rotted farm manure.' "

Plant breeding, or at any rate the selection and propagation of improved types must also have been pursued from very early times. Amongst tropical examples we may cite the countless varieties of rice in the Eastern tropics, the large number of edible seedless bananas in the Indo-Malayan region all necessarily propagated vegetatively, and the races of maize in tropical America "improved" out of all resemblance to any known wild plant.

Early man often took great pains to conserve the fertility of the soil as so well described in F. H. King's *Farmers of Forty Centuries or Permanent Agriculture in China, Korea and Japan*, a book which all should read. As a more tropical example there is the case of Ceylon where for some 1,500 years the food supplies for a large population were grown in the arid northern region with the aid of an excellent system of irrigation works. The evidence of the bygone civilization of this district is indicated now by the famous Buried Cities. European man favoured the wet montane areas for his coffee, and later tea plantings, but was not so wise in his methods. As Mr. John Still says in his charming book on Ceylon entitled *The Jungle Tide*, "it is now about one century since coffee-planters attacked the forests of the hills. They have at last begun to conserve the soil, but in the early days of planting they lived on nature's capital, and the humus laid in store by the leaf fall of millions of years was flayed off by the rainfall of a few thousands of days when first the soil was denuded of its protecting forests, and carried down in spate to the sea; and now the older tea lives on fertilizers."

"In time the jungle tide will swing once more, and then those who care for other things than wealth will wander back to the wet side of the monsoon line, and while elephants browse where tea is now plucked, antiquaries will unearth the ancient bungalows of the British period, or even of the Scottish which will lie beneath it, and classify the different kinds of bottles found among the ruins, and arrange them in museums. Having both planted tea and arranged the antiquities of a museum, I venture to prophesy that this picture will be realized in very much less than fifteen centuries, perhaps in one-fifth of that, or perhaps in one-tenth."

There are many other tempting topics to touch upon, but I must not digress further. I have attempted to sketch, however cursorily, the development of our modern agricultural organisations in the tropical colonies. Our own knowledge and experience of agriculture in those countries is as yet very limited, whilst in many countries our officials come into touch with, and have to serve as advisers to, peoples whose agricultural practices are based on experience gained through many centuries. All I would urge now on the young agriculturist is to go out with an open mind prepared to admit that if a native people do not follow some recognized British practice it is not necessarily because they are foolish or obstinate. By study of their methods he may arrive at the reason for them, and then with the modern resources at his command be able to lead them on to improvements.

# DRESSINGS FOR STOCK.

*By G. F. Gee, H.D.A.*

On recent patrols it has been found that very little attempt is made by planters to obviate fly strike on sores in cattle, or after castration of stock, except that in some cases a coating of tar is painted on. Although better than nothing, this is not entirely suitable as a hard scab is formed, under which maggots or organisms may develop, if present before the application.

Two recipes are given below which are very suitable for treating sores and castration wounds. The first is very cheap and gives good results. The second acts also as a fly repellant, but is more expensive.

When castrated stock become blown, care should be taken to remove all maggots present by the use of forceps and the dressing then applied.

(1) *Wound Oil*—

| | |
|---|---|
| Creosote .. | .. 1 part |
| Turpentine .. | .. 16 parts |
| Linseed Oil .. | .. 48 parts |

(2) *Antiseptic Oil*—

| | |
|---|---|
| Iodoform .. | .. 1 part |
| Eucalyptus Oil | .. 14 parts |
| Olive Oil .. | .. 20 parts |

BOUNTY PAID UNDER PAPUA AND NEW GUINEA BOUNTIES ACT ON IMPORTATION INTO AUSTRALIA FROM THE TERRITORY OF NEW GUINEA.

| Year. | Cocoa Beans. | | Nutmeg. | | Mace. | | Total Bounty. |
|---|---|---|---|---|---|---|---|
| | lb. | £ s. d. | lb. | £ s. d. | lb. | £ s. d. | £ s. d. |
| 1926–27 .. | .. | .. | .. | .. | .. | .. | Nil |
| 1927–28 .. | 29,501 | 184 7 7 | .. | .. | .. | .. | 184 7 7 |
| 1928–29 .. | 262,104 | 1,630 10 4 | .. | .. | .. | .. | 1,630 10 4 |
| 1929–30 .. | 169,325 | 1,058 4 6 | 150 | 0 18 9 | .. | .. | 1,059 3 3 |
| 1930–31 .. | 151,096 | 944 7 1 | 211 | 1 6 5 | 23 | 0 2 10 | 945 16 4 |
| 1931–32 .. | 163,449 | 829 15 0 | 126 | 0 12 7 | .. | .. | 830 7 7 |
| 1932–33 .. | 126,266 | 631 5 9 | 145 | 0 14 6 | 27 | 0 2 8 | 632 2 11 |
| 1933–34 .. | 165,477 | 830 15 0 | .. | .. | .. | .. | 830 15 0 |
| 1934–35 .. | 286,039 | 1,430 3 3 | .. | .. | .. | .. | 1,430 3 3 |
| 1935–36 .. | 233,164 | 1,165 16 1 | .. | .. | .. | .. | 1,165 16 1 |
| 1936–37 .. | 257,094 | 1,285 8 9 | .. | .. | .. | .. | 1,285 8 9 |
| Total to 30.6.37.. | 1,843,515 | 9,990 13 4 | 632 | 3 12 3 | 50 | 0 5 6 | 9,994 11 1 |

BOUNTY PAID ON IMPORTATIONS INTO AUSTRALIA FROM PAPUA.

| Year. | Cocoa Beans. | | Kapok. | | Sisal Fibre. | | Total Bounty. |
|---|---|---|---|---|---|---|---|
| | lb. | £ s. d. | lb. | £ s. d. | Tons cwt. lb. | £ s. d. | £ s. d. |
| 1926–27.. | .. | .. | .. | .. | .. | .. | .. |
| 1927–28.. | 1,610 | 10 1 3 | .. | .. | .. | .. | 10 1 3 |
| 1928–29.. | 1,643 | 10 5 5 | .. | .. | .. | .. | 10 5 5 |
| 1929–30.. | .. | .. | .. | .. | .. | .. | .. |
| 1930–31.. | .. | .. | .. | .. | 6 14 8 | 40 4 5 | 40 4 5 |
| 1931–32.. | .. | .. | .. | .. | .. | .. | .. |
| 1933–34.. | .. | .. | 2,007 | 13 7 7 | .. | .. | 13 7 7 |
| 1934–35.. | .. | .. | .. | .. | .. | .. | .. |
| Total | 3,253 | 20 6 8 | 2,007 | 13 7 7 | 6 14 8 | 40 4 5 | 73 18 8 |

# A HANDY BREEDING TABLE.

*By G. F. Gee.*

The following table should be of assistance to those planters breeding different classes of stock throughout the Territory:—

| Date of Service. | Cattle. 283 Days. | Horses. 340 Days. | Pigs. 112 Days. | Goats. 147 Days. | Sheep. 150 Days. | Dogs. 63 Days. |
|---|---|---|---|---|---|---|
| 1st Jan. .. | 10th Oct. | 6th Dec. | 22nd Apr. | 27th May | 30th May | 4th Mar. |
| 8th Jan .. | 17th Oct. | 13th Dec. | 29th Apr. | 3rd June | 6th June | 11th Mar. |
| 15th Jan. .. | 24th Oct. | 20th Dec. | 6th May | 10th June | 13th June | 18th Mar. |
| 22nd Jan. .. | 31st Oct. | 27th Dec. | 13th May | 17th June | 20th June | 25th Mar. |
| 29th Jan. .. | 7th Nov. | 3rd Jan. | 20th May | 24th June | 27th June | 1st Apr. |
| 5th Feb. .. | 14th Nov. | 10th Jan. | 27th May | 1st July | 4th July | 8th Apr. |
| 12th Feb. .. | 21st Nov. | 17th Jan. | 3rd June | 8th July | 11th July | 15th Apr. |
| 19th Feb. .. | 28th Nov. | 24th Jan. | 10th June | 15th July | 18th July | 22nd Apr. |
| 26th Feb. .. | 5th Dec. | 31st Jan. | 17th June | 22nd July | 25th July | 29th Apr. |
| 5th Mar. .. | 12th Dec. | 7th Feb. | 24th June | 29th July | 1st Aug. | 6th May |
| 12th Mar. .. | 19th Dec. | 14th Feb. | 1st July | 5th Aug. | 8th Aug. | 13th May |
| 19th Mar. .. | 26th Dec. | 21st Feb. | 8th July | 12th Aug. | 15th Aug. | 20th May |
| 26th Mar. .. | 2nd Jan. | 28th Feb. | 15th July | 19th Aug. | 22nd Aug. | 27th May |
| 2nd Apr. .. | 9th Jan. | 7th Mar. | 22nd July | 26th Aug. | 29th Aug. | 3rd June |
| 9th Apr. .. | 16th Jan. | 14th Mar. | 29th July | 2nd Sep. | 5th Sep. | 10th June |
| 16th Apr. .. | 23rd Jan. | 21st Mar. | 5th Aug. | 9th Sept. | 12th Sept. | 17th June |
| 23rd Apr. .. | 30th Jan. | 28th Mar. | 12th Aug. | 16th Spt. | 19th Sept. | 24th June |
| 30th Apr. .. | 6th Feb. | 4th Apr. | 19th Aug. | 23rd Sept. | 26th Sept. | 1st July |
| 7th May .. | 13th Feb. | 11th Apr. | 26th Aug. | 30th Sept. | 3rd Oct. | 8th July |
| 14th May .. | 20th Feb. | 18th Apr. | 2nd Sept. | 7th Oct. | 10th Oct. | 15th July |
| 21st May .. | 27th Feb. | 25th Apr. | 9th Sept. | 14th Oct. | 17th Oct. | 22nd July |
| 28th May .. | 6th Mar. | 2nd May | 16th Sept. | 21st Oct. | 24th Oct. | 29th July |
| 4th June .. | 13th Mar. | 9th May | 23rd Sept. | 28th Oct. | 31st Oct. | 5th Aug. |
| 11th June .. | 20th Mar. | 16th May | 30th Sept. | 4th Nov. | 7th Nov. | 12th Aug. |
| 18th June .. | 27th Mar. | 23rd May | 7th Oct. | 11th Nov. | 14th Nov. | 19th Aug. |
| 25th June .. | 3rd Apr. | 30th May | 14th Oct. | 18th Nov. | 21st Nov. | 26th Aug. |
| 2nd July .. | 10th Apr. | 6th June | 21st Oct. | 25th Nov. | 28th Nov. | 2nd Sept. |
| 9th July .. | 17th Apr. | 13th June | 28th Oct. | 2nd Dec. | 5th Dec. | 9th Sept. |
| 16th July .. | 24th Apr. | 20th June | 4th Nov. | 9th Dec. | 12th Dec. | 16th Sept. |
| 23rd July .. | 1st May | 27th June | 11th Nov. | 16th Dec. | 19th Dec. | 23rd Sept. |
| 30th July .. | 8th May | 4th July | 18th Nov. | 23rd Dec. | 26th Dec. | 30th Sept. |
| 6th Aug. .. | 15th May | 11th July | 25th Nov. | 30th Dec. | 2nd Jan. | 7th Oct. |
| 13th Aug. .. | 22nd May | 18th July | 2nd Dec. | 6th Jan. | 9th Jan. | 14th Oct. |
| 20th Aug. .. | 29th May | 25th July | 9th Dec. | 13th Jan. | 16th Jan. | 21st Oct. |
| 27th Aug. .. | 5th June | 1st Aug. | 16th Dec. | 20th Jan. | 23rd Jan. | 28th Oct. |
| 3rd Sept. .. | 12th June | 8th Aug. | 23rd Dec. | 27th Jan. | 30th Jan. | 4th Nov. |
| 10th Sept. .. | 19th June | 15th Aug. | 30th Dec. | 3rd Feb. | 6th Feb. | 11th Nov. |
| 17th Sept. .. | 26th June | 22nd Aug. | 6th Jan. | 10th Feb. | 13th Feb. | 18th Nov. |
| 24th Sept. .. | 3rd July | 29th Aug. | 13th Jan. | 17th Feb. | 20th Feb. | 25th Nov. |
| 1st Oct. .. | 10th July | 5th Sept. | 20th Jan. | 24th Feb. | 27th Feb. | 2nd Dec. |
| 8th Oct. .. | 17th July | 12th Sept. | 27th Jan. | 3rd Mar. | 6th Mar. | 9th Dec. |
| 15th Oct. .. | 24th July | 19th Sept. | 3rd Feb. | 10th Mar. | 13th Mar. | 16th Dec. |
| 22nd Oct. .. | 31st July | 26th Sept. | 10th Feb. | 17th Mar. | 20th Mar. | 23rd Dec. |
| 29th Oct. .. | 7th Aug. | 3rd Oct. | 17th Feb. | 24th Mar. | 27th Mar. | 30th Dec. |
| 5th Nov. .. | 14th Aug. | 10th Oct. | 24th Feb. | 31st Mar. | 3rd Apr. | 6th Jan. |
| 12th Nov. .. | 21st Aug. | 17th Oct. | 3rd Mar. | 7th Apr. | 10th Apr. | 13th Jan. |
| 19th Nov. .. | 28th Aug. | 24th Oct. | 10th Mar. | 14th Apr. | 17th Apr. | 20th Jan. |
| 26th Nov. .. | 4th Sept. | 31st Oct. | 17th Mar. | 21st Apr. | 24th Apr. | 27th Jan. |
| 3rd Dec. .. | 11th Sept. | 7th Nov. | 24th Mar. | 28th Apr. | 1st May | 3rd Feb. |
| 10th Dec. .. | 18th Sept. | 14th Nov. | 31st Mar. | 5th May | 8th May | 10th Feb. |
| 17th Dec. .. | 25th Sept. | 21st Nov. | 7th Apr. | 12th May | 15th May | 17th Feb. |
| 24th Dec. .. | 2nd Oct. | 28th Nov. | 14th Apr. | 19th May | 22nd May | 24th Feb. |
| 31st Dec. .. | 9th Oct. | 5th Dec. | 21st Apr. | 26th May | 29th May | 3rd Mar. |

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