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THE SWEET POTATO HAWK MOTH.

Hippotion celerio.

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

This pest was referred to in a previous issue of this *Gazette,** but further information has been obtained on certain aspects of the problem, which it is proposed to bring forward in reply to various inquiries recently made in connexion with its depredations.

The adult moth measures about 2½ inches across the outspread wings, of which the fore pair are brown with whitish lines and the hind pair reddish with dark markings. They are very swift fliers, and normally only move about at night; they are rather attracted to light.

The eggs are laid on the foliage and take three to four days to mature. The young grubs feed from the under-surface of the leaves and are light green in colour with a dark spine projecting upwards from the back at the anal end of the body. (This spine is a characteristic feature of the caterpillars of this group of moths.)

The full-grown caterpillars are 2–2½ inches in length, and vary in colour to almost black. During the last three days of their development, a much greater quantity of foliage is consumed than in the earlier periods.

When feeding is completed, the caterpillars burrow into the soil to transform into the chrysalis, which is a resting stage. The caterpillars take 10–12 days to reach maturing and the chrysalis occupies 15–18 days, before the adult moth emerges. As the moths die very quickly in captivity, the life of the adults has not been determined.

The incidence of this pest varies markedly with the seasons, often becoming a serious pest during dry weather conditions.

Insect Parasites and Predators.

The maggots of a fly, *Carcelia kokiana,* Towns (*Tachinidae*), are a parasite of the caterpillars of the sweet potato hawk moth, and are at times very numerous.

The adults and nymphs of a bug, *Platynopus malacanthus,* Boisd, (*Pentatomidae*) have been collected when feeding on the caterpillars of *H. celerio.*

Other Predators.

Bufo marinus, the giant toad, has been introduced in an attempt to cope with this and other pests.

Fowls and ducks will not apparently eat the caterpillars.

Mechanical Measures.

Spraying with *arsenate of lead,* 1 lb to 50 gallons of water, or dusting with 10 per cent. *arsenate of lead* or *calcium arsenate,* will control the pest if carried out as soon as the caterpillars are seen or the moths are observed to be laying eggs.

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* Vide *New Guinea Agricultural Gazette,* Vol. 2, No. 1, January, 1936, page 13.

In normally fine weather, three treatments at intervals of about ten days should be sufficient, but heavy rain after dusting or spraying will necessitate further treatments. Dusting is best carried out in the early part of the morning, while the dew is on the foliage, when a better adhesion of the dust is obtained. The nozzle should be depressed so as to drive the powder downwards.

Spraying necessitates the use of an end piece and nozzle that will enable the spray to be directed on to the underneath surface of the foliage.

Light Traps.

As these moths are attracted to light, a trap can be made as follows:—Make a shallow pan (e.g., bending up the edges of a sheet of galvanized iron), fill it with water and cover with a film of kerosene. In the middle stand a lamp with a strong light surrounded with a light framework over which thin white lava-lava or calico is tightly stretched. This can be set out in the area under crop at night soon after dark. The moths coming to the light fall into the water and are drowned.

The only disadvantage of these traps is that beneficial insects may also be killed.

Other Hosts.

Taro (*Colocasia* spp.) and *Caladiums* are at times severely attacked by this pest, the foliage being stripped to the midribs of the leaves.

COCKROACHES AND THEIR CONTROL.

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

These household pests are nocturnal in habit, hiding in any dark crevices, corners or cupboards during the day, and coming out to feed at night. Kitchens are particularly favoured by the attention of these obnoxious insects, but by carefully locating any sheltering sites are fairly easily treated.

The most satisfactory chemical for killing these insects is *sodium fluoride,* a white powder. Although poisonous to humans, if taken internally in sufficient quantity, provided reasonable care is taken in its use, the risk of contamination of foods is negligible.

The best method of reaching the cockroaches is to dust this powder into crevices by means of a small blow-gun or bellows, or scatter it on the floor and shelves of cupboards. The insects pick up the powder on the legs and antennae ("feelers") and, in order to clean off the powder, drain these members between the mouth parts; by this means the poison passes to the stomach and kills the insects.

In dry situations, the powder remains more or less indefinitely, but where subject to moisture, it is liable to cake and become useless. In such cases, it may be advisable to blow the dust into the hiding places once a week at least.

Another matter that should receive careful attention is the masses of eggs. These are enclosed in a brown capsule about half an inch long and rounded on the ends; the outer side is often covered with a white mealy-like powder. These are placed in cracks along wainscotting, crevices, behind doors, &c. Wherever found, they should be destroyed, as each capsule contains a number of eggs.

As cockroaches breed in heaps of decaying leaves, &c., care should be taken to turn over periodically any heaps of garden rubbish, &c., in the vicinity of dwellings.

VETERINARY SCIENCE NOTES.

Lameness in the Horse.

(By I. J. L. Wood, Q.D.A.)

The following notes may be of interest to horse-owners in the Territory:—

Lameness is the most common ailment of the horse, and is responsible for about 75 per cent. loss of service.

The majority of cases of lameness is due to either careless or wrong methods of handling, and, thus, a large proportion of loss of services is preventable.

Lameness may be defined as a visible symptom of pain, and at least 80 per cent. results from injuries below the knee and hock, although to the average layman the common seat is located in the shoulder. In actual fact shoulder lamenesses are very rare.

It is marked in progression by definite symptoms commonly known as dropping, indicated when the forequarters are affected, by a lowering of the head and a dropping of the shoulder when the non-affected limb contacts with the ground. When in the hind limb, dropping occurs in the opposite hip to the affected limb.

Horses at rest show signs of pain in the limb by what is termed "pointing". This refers to the position in which the affected limb is held. Where the trouble is below the knee, the foot is usually carried slightly forward; when above the knee, the limb is slightly flexed with the toe resting on the ground slightly behind its fellow.

Lameness may be divided into two classes—

(1) Those due to traumatic causes, i.e., wounds and bruises.

(2) Those due to bony unsoundness.

(1) Most cases of lameness are due to wounds, injuries and muscular strains. They are rarely serious and usually respond to the treatment of rest for a few days.

Most strains result in the presence of slightly increased heat in the part and soreness when moved or palpated.

To relieve, apply a cooling lotion and then give absolute rest for a few days. After all inflammatory changes have been reduced the application of a mild stimulant or blister over the part will stimulate the blood supply and hasten recovery.

(2) Perhaps more important than the muscular conditions are those arising from what are termed bone diseases. The common bone diseases are splints, ringbones, spavins and sidebones, though the latter is not truly a bone disease.

Splints.—These are bony enlargements which form between the small and large metacarpal or metatarsal bones. They may form anywhere throughout the small bones, but are usually found in the "middle third". Occasionally, they develop in the vicinity of the knee joint and are then known as high splints, a type which is usually difficult to treat successfully, owing to its proximity to the joint.

Splints are due to concussion. A common cause of splints is coarseness of bone and bad conformation by which concussion is not evenly distributed. Where horses are shod, splints may occur in perfectly developed bone and correct conformation as the result of bad shoeing.

As the result of the concussion, irritation is set up beneath the periosteum causing an exudation of fluids which press on the nerves lying within the

periosteum. At this stage, a splint is painful, particularly at the trot. In course of time, the fluid is impregnated with mineral matter, converting it into bone tissue. Usually, by this time, all symptoms of pain have ceased.

Treatment.—First, rest, with applications of cooling lotions to the affected part. When the inflammation is reduced, use a strong blister compound—one part of biniodide of mercury and four parts of lard or vaseline. The area immediately over the splint should be clipped, then well washed with water and soap to cleanse the pores. A small quantity of the blister should be applied immediately over the enlargement and rubbed into the skin for about ten minutes, after which any surplus blister should be removed. Then surround the area on the sides and beneath with vaseline or lard, thus restraining the action to the desired area. Next tie the animal's head up short and keep it tied up until the blister has ceased to act, usually 5–6 hours. Unless the head be tied up short the animal will endeavour to bite the area, resulting in a blistering of the mouth and tongue. After the action has ceased, wash the area with warm water and soap and then apply grease. This will prevent sloughing of the skin.

Ring Bones.—A bony exostosis occurring on the Pastern bones and interfering with the movement of the joints. When the exostosis involves the Suffraginus coronae articulation it is known as a high ring bone; when the Coronae pedis articulation, a low ring bone. The latter is generally difficult to diagnose, as the area is within the upper border of the wall of the foot.

For ring bone there is no known treatment of curative value. Ring bone is classed as one of the hereditary unsoundnesses believed to be due to faulty conformation.

Spavin.—An exostosis involving the hock joint. The usual situation is the antro-internal aspect of the hock.

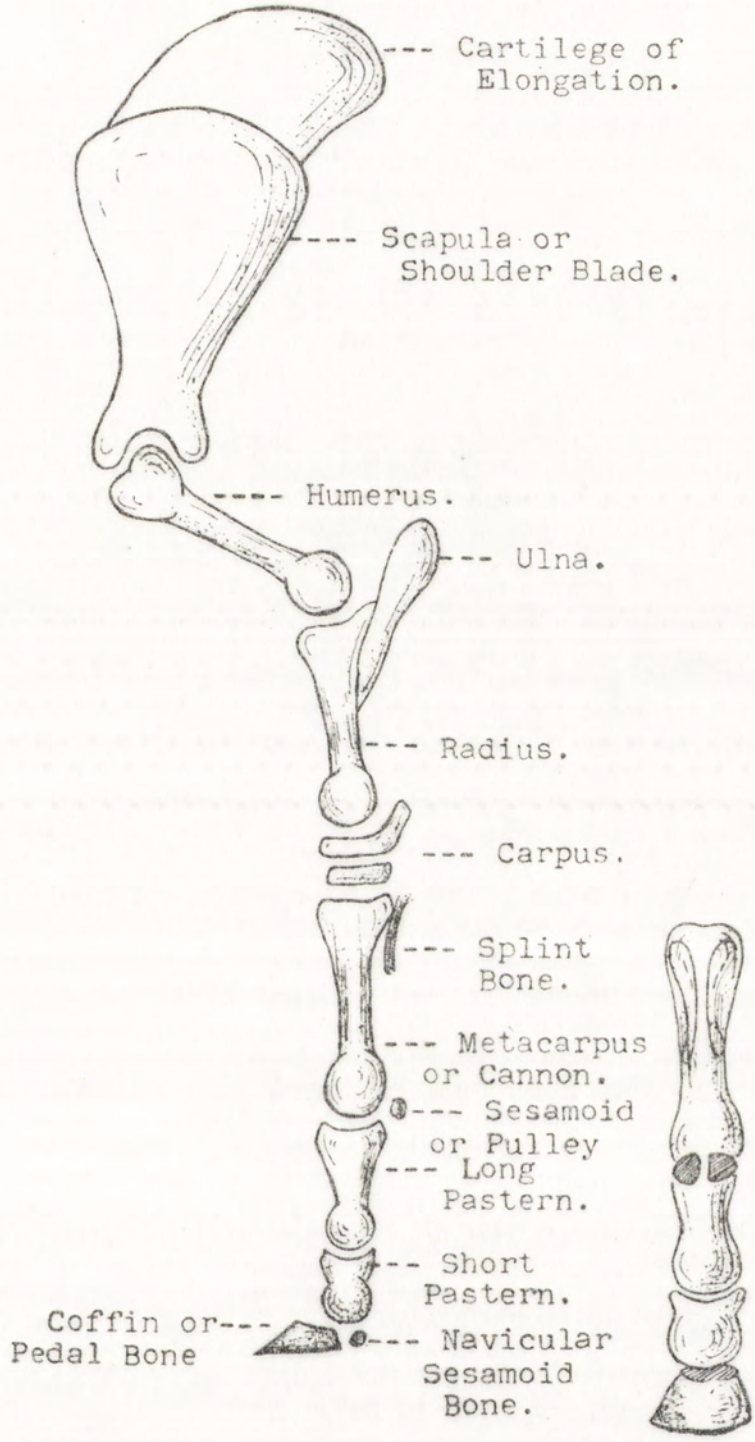
Occasionally the position occurs between the bones without external manifestations. This is known as an "occult spavin", a variety which can only be diagnosed by action. An animal suffering from spavins does not carry the limb forward to the full extent and the toe strikes the ground at the end of the movement.

There is no curative treatment. Blistering the affected part relieves the painful stage.

Side Bones.—An ossification of the lateral cartilages situated in the upper border of the wall. Similarly to ring bones and spavins, side bones are classed as hereditary unsoundness. Normally this cartilage should be soft, elastic and springy under pressure. As the result of the inflammatory discharges becoming impregnated with mineral matter, an animal affected with side bones will quickly go lame on roads with hard surfaces, particularly at fast speeds. With ordinary riding on grassed tracks, an animal with side bones rarely suffers inconvenience or lameness therefrom.

Fore limb bones comprise—

The *scapula* or shoulder blade.
Humerus, radius, ulna, carpus (eight small bones).
Metacarpus (one large and two small bones).
Pasterns (3)—*os-suffraginus, os-coronae,* and *os-pedis.*
Immediately behind the fetlock joint are two small oval bones (*sesamoids*), and behind the *os-pedis,* the *naviculae.*


--- Cartilege of Elongation.
---- Scapula or Shoulder Blade.
---- Humerus.
--- Ulna.
--- Radius.
--- Carpus.
--- Splint Bone.
--- Metacarpus or Cannon.
--- Sesamoid or Pulley
--- Long Pastern.
-- Short Pastern.
Coffin or--- Pedal Bone
--- Navicular Sesamoid Bone.

CLIMATIC NOTES ON NEW GUINEA.

By B. G. Challis.

It is noted that throughout the Territory an increasing interest is being taken in the weather and climate of New Guinea, and for the information of residents generally it is proposed to supplement the attached climatological tables with a few notes on the subject of meteorology as it affects the Territory.

Meteorology may be defined as a study of the atmospheric conditions and its various changes, or, being a branch of the wider science Physics, it is sometimes referred to as the science of the earth's atmosphere, embracing both weather and climate. The study of the latter, however, is separately designated climatology. Climate implies the degree of heat, light and moisture, and affects the suitability or otherwise of a country for vegetable, human or animal life.

With the introduction of scientific methods in industry and commerce, applied meteorology is, of recent years, rapidly coming to the fore and, thus, we have sub-divisions as agricultural, marine, aeronautical and insurance meteorology. From time to time, as circumstances permit, these branches of meteorology will be dealt with through the medium of this *Gazette*.

The following notes, however, deal in a general way only with climatic conditions as met with in the Territory of New Guinea, and readers are cordially invited to communicate with the Department of Agriculture, Rabaul, regarding the weather conditions which they may experience from time to time, so that more detailed information may be collected and more accurate climatological data be made available for the benefit and interest of the Territory generally.

The Mandated Territory of New Guinea is situated 141° to 156° east longitude, and approximately 0°–8° south of the equator and, as its latitudes imply, a typically tropical climate in the narrower sense is experienced, although nothing like the climatic fluctuations which occur between 8° south and 23° south.

To those who have never lived in the tropics, the word "tropics" very often conveys a wrong impression of the actual conditions to be expected. This is perhaps due to the term "temperate climate" applied to the intermediate zones either north or south of the equator, where extremes of temperature, ranging from as low as 0° Fahrenheit to as high as 125° F. are liable to occur. (125° F has been registered at Bourke in New South Wales.)

The tropics are generally defined as ranging from 23° north on the tropic of Cancer to the tropic of Capricorn at 23° south of the equator, but, from a practical geographic point of view, the "tropics" may better be regarded as lying between 10° north and 10° south of the equator, and in these latitudes within which New Guinea lies in the Southern Hemisphere, the temperatures at sea level seldom rise higher than 95° F. or rarely sink below 70° F.—figures which indicate a more temperate climate than those experienced in the more popularly recognized temperate zones with their extreme range of weather conditions. However, as in temperate climates, the temperatures in the tropics are affected by elevation by a drop or lapse rate of about 3° F. in every 1,000 feet of altitude; Humboldt,[4] the great German explorer, discovered that the thermometer fell 1° for every 343 feet of elevation, a fact which is evident by comparing the 1938 tables of climatological stations at Bulolo, 2,200 feet, Aiyura Agricultural

Station, 5,875 feet, and those of the coastal districts capital stations. It is interesting to note that aviators have reported ice accretions on aircraft at 16,000 feet when in flight over the mainland of our Territory, but on descending to about 14,500 feet such ice formation disappeared. Falls of snow have been reported on Mount William (approximately 15,000 feet).

The situation of the many islands which comprise the Territory permits of a free circulation of air so that, from a general point of view, the climate resembles that of the ocean near the equator, i.e., with high average temperature and stable atmospheric conditions, and thus we have along the coastal belts, a maximum isothermic average of about 88° F. and a minimum average of 75° F. and a mean of 82° F. It will be observed that there is little seasonal variation between the cooler and warmer months. The range being about 3°.

In the Territory there is no winter with its short days and long nights, or summer days of a converse nature. The sun daily ascends and descends almost perpendicularly with the horizon, so that dawn and twilight are of short duration. There is but little apparent change in the sun's position daily at noon, when the sun stands practically overhead, and, in consequence, there is only a small daily temperature variation, and only about half an hour difference between extreme times of sunrise and sunset, during the course of a year.

Slight variations in temperature become distinctly noticeable to acclimatized tropical residents, despite the small temperature range. There are other atmospheric conditions, such as humidity, which affect the human senses, but there is no fear of heat wave visitations such as were experienced in Australia during the last summer, when high record temperature registrations were reported in most States.

Actually New Guinea, with its widespread area of 93,000 square miles ranging from the large mainland area with mountain peaks of about 15,000 feet to numerous islands of diversified shapes and sizes, presents many climatic variations, but broadly regarded, along the coastal belts, where most Europeans are settled either in business or agriculture, the climate is hot and moist; whereas in the mining settlements of the highlands weather conditions are cooler and more pleasant. In the plain country, there is a greater range of the minima and maxima temperatures which is doubtless due to greater radiation. There is, however, that "everlasting sameness" which has an enervating effect on the populace, but this can be combated with attention to suitable diet and a moderate amount of exercise.

Weather conditions as affecting man in the tropics have been comprehensively dealt with by Dr. Douglas H. K. Lee[5] in a series of articles, entitled *The Tropics and Man* which appeared last year in the *Queensland Agricultural Journal*, and these observations are applicable to New Guinea.

Generally speaking, our calendar year is divided into two seasons which correspond to the periods in which the south-east trade winds or the north-west monsoons prevail. Fortunately, New Guinea is outside the hurricane zone. Squalls are often experienced, especially during the north-west monsoon period, but it is thought that there is a tendency to exaggerate their intensity by European residents who are accustomed to more open-air housing conditions than they may have known in other countries.

WINDS.

Changes in Weather Conditions.

Although New Guinea has nothing that can be described as summer or winter, there are changes in weather conditions, due sometimes to general and sometimes to local causes.

Local Causes.

Land and Sea Breezes.—The local cause is attributed to gravity winds, sea and land breezes. Land and sea breezes are felt only along the coastal areas of the larger land masses throughout the islands.

The explanation of the local breeze is that as the day progresses and the sun shows itself above the horizon, the land becomes warmer more rapidly than the adjacent sea, owing to the sun pouring down a stream of radiant energy or insolation, which on contact with the land manifests as heat and causes a rise in temperature. The land surface being a better absorber than the sea surface, it is naturally a better radiator of heat when subject to the same amount of insolation, so that in the mornings the air above the land becomes warmer than the air above the water. The warm air then rises, and is replaced by damp and denser air flowing in from the sea, and this particular indraft of air is known as a sea breeze. As this incoming air in its turn rises, it cools and its moisture condenses to form heavy cumulus clouds. Towards sunset, the reverse process of air flow takes place through the sea losing its radiation more slowly than that of the land. This results in upward convection currents over the sea due to its lessened density, thus setting up a land breeze, and the cooler air from the mountains descends to the sea where it becomes warmed again, thus preserving the equilibrium unless the monsoonal or trade winds cause a change in this sequence.

The configuration and vegetation of the land in some portions of the Territory have a marked effect on the development of land breezes and, unless a considerable land mass is adjacent from which radiation can emanate, it is unlikely that local winds will form to any extent.

Land and sea breezes are most noticeable off the mainland, and the islands of New Britain, Manus, New Ireland and Kieta.

Land and sea breezes seldom reach a height beyond 1,500 feet or attain a velocity above 10-15 miles per hour, nor do they extend their influence inland, nor beyond about 12 miles or 10 miles out to sea.

Gravity Winds.

Gravity winds are perhaps best known in the Markham Valley and other parts of the mainland ranges, but they are also prevalent in other parts of the Territory where high mountain ranges are also in evidence, such as Kieta, which has Mount Balbi, 10,170 feet, New Britain–Ulawun (The Father), 7,546 feet, and Mount Bamus (South Son), 7,376 feet. The intensity of these winds will of course be influenced by the relief features of the land.

The gravity winds are purely local winds and often bear no relation to the distribution of the general atmospheric pressures.

During the day, the sun warms the ground in the valleys and an upward flow of air is commenced due to the convection of heated air. As the air in the valleys becomes warmed, its density decreases and as heated air rises, it flows up the valleys of mountain slopes in the form of an *Anabatic* wind.

At night the reverse process occurs, and a different wind called *Katabatic* is experienced in the hills.

Particularly on clear nights, the radiation from the ground is greater on the mountain tops than in the valleys, because at the higher altitudes there are less dust particles and water vapour particles in the air to intercept the radiation and thus to absorb or reflect it. Hence, we find that the air on the surface of a hill is colder than the air at some distance from the surface, and as it is colder air, and, therefore, denser at the tops of the ranges, a flow of air will gravitate in the direction of the slopes to form a *Katabatic* wind. Under favorable conditions, such as the augmentation of the seasonal winds, these gravity winds develop quite high velocities, but generally they are quite mild.

Upper Winds.

At present no data is available on the upper winds of New Guinea, although experiments in this respect are now being conducted by the aid of pilot balloons at Salamaua and Rabaul.

The opinion at present held is that above the local winds, the trades and monsoons prevail, whilst above the seasonal winds, the direction of the winds is reversed to preserve the general atmospheric wind equilibrium.

Lull of Wind at Night.

Normally, we experience a lull in the wind after sunset and until sunrise. This drop in the force of the wind is not in evidence far out to sea nor above about 1,000 feet.

The lighter winds in the evening are a result of lack of heating from the sun's radiation. This does not allow for convective rising and mingling of the lower layers with the upper, and these lower layers therefore do not receive any impulsive force from above.

During the day the opposite effect is in operation. The sun's radiation heats the lower layers of the atmosphere by convection, and these rise and become connected up with the upper layers, which exert a driving force on them thus increasing their velocity which, were it not for the friction of the ground, would approximate closely to the velocities in the upper layers.

It is of course assumed that there is a steady wind blowing in the upper layers, which is not always the case as in the months of change of season, but it is true for the major parts of the year, during the north-west monsoon and south-east trades.

This lull in the wind is more noticeable during nights of clear sky when the clouds cannot cause a blanketing effect, and prevent free radiation from the earth's surface. On clear nights, radiation from the earth is greatest and thus cooling off is greatest. Under such conditions, the density of the air in contact with the earth's surface increases, and this greater density means a greater lulling of the wind.

The velocity of the wind at the earth's surface is usually greatest in the early afternoon, and least before dawn, but, at the tops of hills, the reverse conditions generally operate.

Seasonal Winds.

Whereas land, sea and gravity winds are local in origin and develop daily within confined, limited areas, the seasonal winds of New Guinea are felt more generally. They divide the year into two seasons and are classified as the north-west monsoon which blows intermittently from December to April, and the south-east trades which prevail from about the end of April to early November,

Sometimes these seasonal winds are referred to as monsoons.[6] "Monsoon" is derived from the Arabic "season", but strictly speaking, monsoons are restricted to Southern Asia and the East Indies where the word monsoon is often used to denote the "rains", more especially the rains which accompany the south-west seasonal winds in those parts.

Monsoons are caused by the seasonal difference of variation of temperature between land and sea areas, and change with the summer and winter of the temperate zones of Southern Asia, where exceptionally high and low barometric pressures operate in summer and winter respectively. In New Guinea, there is very little variation in temperature or barometric pressure throughout the year, and the only monsoonal wind felt is when the north-east monsoon off Southern Asia is deflected into a north-west wind during its passage across the equator, and blows intermittently until its strength is lost in the doldrums—the zone of calms and light variable winds which move north and south of the equator with the annual change of the sun's declination.

The change in the direction of this north-east monsoon off Southern Asia is accounted for by the fact that the earth's velocity at the equator is about 1,000 miles per hour from west to east with an easing off to zero at the North and South Poles. This action gives effect to Professor Buys Ballot's[1] Law which states that—"If in the Northern Hemisphere you stand with your back to the wind, the wind pressure is lower on your left hand, but if in the Southern Hemisphere you stand with your back to the wind, pressure is lower on your right hand".

The more prevalent seasonal wind in New Guinea is the south-east trade—a name originating in the days of sail "to blow trade", meaning to blow constantly in the same direction. This nautical phrase was subsequently shortened to the word "trade".

It is of interest to note that the monsoons were formerly grouped with the trades.

The trades circulate from the great permanent oceanic high pressures at 30° north and 30° south of the equator, and these characteristically regular trades encountered in this Territory sweep up from about latitude 30° south during the winter season of the Southern Hemisphere. Similar trades blow from the north during the winter of the North Hemisphere, but the Indian Ocean and China Seas are exceptions to this general rule and it is from the last-named direction that our north-west monsoons are derived.

The trades are supposed to be constant in force, but closer observations reveal that they are variable when interrupted by contact with the land masses with their local winds and other atmospheric influences. It is generally recognized

in meteorological circles that although throughout the Pacific Oceans, the south-east crosses the equator during the summer of the Northern Hemisphere the north-east trade does not extend to the south of the equator. As New Guinea lies in the southern latitudes, the names given to our seasonal winds are the north-west monsoon (December to April) and south-east trade (May to November).

Both of these seasonal winds carry moisture but the degree of precipitation which occurs is regulated by the height and situation of the land which they strike en route. The rains very often fall in more violent showers than in the more temperate latitudes. The physical features of New Guinea being so varied they account for the diverse monthly and annual rainfall averages shown on the rainfall map. While the seasonal winds are blowing strongly, they overcome the land and sea breezes, but if only blowing moderately, the land and sea breezes will cause a small daily variation in the strength and direction of the seasonal winds near the coasts.

South-East Trades.

As previously mentioned, the south-east trades prevail throughout the Territory from May to November. They make their appearance about the end of April, and gradually increase and freshen in force until July, when the winds continue with marked regularity until October. Their force is then abated by the presence of the north-west monsoon which at this period begins to assert itself against the trade in the upper layers, thus causing the calms experienced during November and correspondingly around April with the change of seasons.

Wind roses have not been prepared to indicate the strength and direction from which the various winds blow, but it is recognized from general observations that in the Admiralty Group and along the north coast of the mainland, so far as the south-east trade is concerned, its strength is more intermittent in character while its course is deflected in such places as St. George's Channel, Dampier and Vitiaz Straits, where it follows the trend of the land, which thus gives it a more southerly direction.

Where the orographical features permit, as in the Huon Gulf and south coast of New Britain, there is a particularly heavy rainfall during the period in which the south-east trade prevails.

In July, when the south-east reaches its maximum intensity, the wind sometimes blows strongly for stretches up to a fortnight. In crossing the New Britain ranges much of the moisture content is lost on the southern side of the island, but the wind continues with but little lessening in force as far as the Admiralty Islands. It merges in the Doldrums, just north of the equator.

The weather is perhaps a little more hazy during the south-east season.

North-West Monsoon.

The north-west monsoon is of a more intermittent character than the south-east trade and blows with more sudden squalls, and often brings more rain, although it will be noted that in the more exposed islands, the rainfall is fairly regular in most months of the year.

The presence of the north-west monsoon is first felt in the northern part of the Territory in November, and its influence is gradually extended southwards until about Christmas time when it may be considered to be general throughout

the islands. There is considerable variation in the strength and direction of the winds during January to March and unsettled conditions and heavy rains are frequently the order of the day. It should be noted, however, that along the Finisterre Range south-east from Madang, in the Huon Gulf and on the south coast of New Britain, this is considered to be the dry season, because in these parts it is found that the north-west monsoon is less effective.

Change in Seasons.

The change in seasons usually covers a period of five or six weeks between April-May and November-December when either the monsoon or trade wind is losing its force, and neither wind has full charge of the higher atmospheric movement. At such times the weather is generally more humid and oppressive, and thunderstorms in the afternoon often occur.

Along the coastal areas the early morning skies are often clear or have high cirrus clouds. By about 9 a.m. to 10 a.m. cumulus or cauliflower-shaped clouds form and continue to develop until the afternoon, when very often thunderstorms are likely to occur. Thunderstorms also occur out to sea, and are more generally found to occur in the early hours of the morning, due to night radiation from the cloud tops, but are usually later in breaking out than over the land.

It has been found that the electrical potential in the region of lofty mountain peaks is often very high. Increase in electrical potential is recorded where the warm air from the sea coast, carrying dense masses of water vapour from the sea, is forced up the high mountain slopes, and the electrical charge increases with condensation. Thus there would be more liability to lightning near very high mountains (e.g. lightning strike in coco-nuts is particularly severe at the foot of Mt. Balbi, 10,170 feet, Bougainville Island). Although under moist conditions, the potential need not be so great as in a dry atmosphere, the exaggerated causes here due to altitude are more pronounced in the tropics. Of course, other factors may cause particular areas to be liable to severe lightning storms.

Frequently between 9 a.m. to 10 a.m., the seasonal winds which have abated during the night, begin to blow again to some degree, although it should be noted that they often blow throughout the upper air layers during the night. Where there is so often a comparatively clear sky in the mornings, as already mentioned, places with an eastern exposure receive more sunshine compared with a similar position to the west.

Pressure.

In the winter of the Northern Hemisphere the average pressure is very high over Asia and the North Pacific while at the same time there is a corresponding low in Australia. In the summer of the Northern Hemisphere the pressure distribution is reversed. New Guinea lies practically between these defined pressure zones, but being subject to tropical oceanic conditions, there is very little isobaric change along the coast, although a slight increase is noticeable in the transition periods of the Asiatic and Australian pressure zones.

At mean sea level within the Territory the average pressure differs little from about 1008.5 millibars or 29.78 inches and 3.5 millibars would cover the range between highest and lowest monthly average values.

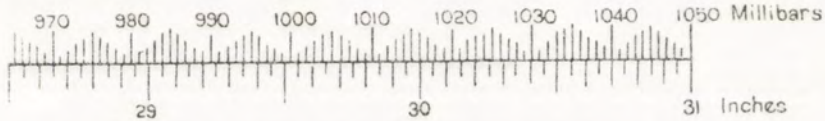
Twice daily there are rises and falls in the barometer. At 9 a.m. and 10 p.m. it reaches its highest and at 4 a.m. and 4 p.m. isobaric pressure is lowest. Any departure from this diurnal variation may indicate a change of weather.

Where there is a defined wet and dry season, as in Rabaul, the average monthly pressure is higher in the dry season than in the wet. It will be noticed that the morning maximum is often higher in the dry season while in the wet season the evening maximum shows a tendency to be more pronounced.

The greatest difference between highest and lowest barometer readings for Rabaul last year was 10.2 millibars or 3/10ths of an inch.[8] With such small variations it will be seen that aneroid barometers are of little assistance to weather observers in this Territory and that extreme accuracy is necessary in reading mercurial barometers if any value is to be placed on such registrations.

Pressure and Winds—Barometer.

The accompanying diagram shows the equivalent of millibars in inches, and vice versa:—



Humidity.

Frequently this office is called upon for an explanation of humidity. Apparently the relative humidity figures which are published each week in the local press are often the cause of comment on this subject.

Humidity is commonly expressed in relative figures, hence the term *relative humidity*, by which is meant the amount of moisture or water vapour actually in the air to the amount it would have if saturated at a given temperature, or in other words, the air is a certain percentage saturated with moisture. This amount is determined from the readings of the thermometers known as the "dry and wet" bulbs, erected in the shade 4 feet above the surface of the ground, where there is free circulation of air.[3]

The dry bulb (an ordinary thermometer) shows the internal shade temperature of the air, while the wet bulb indicates the external shade temperature of evaporation. The wet bulb is an ordinary thermometer kept covered by wet muslin (changed at least once weekly) attached to a reservoir of distilled or rain water by strands of absorbent cotton thread, which keeps the muslin supplied by capillary attraction. Since evaporation causes cooling, the reading of the wet bulb is lower than that of the dry bulb, unless the air is saturated, or it is raining, in either of which cases evaporation is no longer possible.

If the wet bulb records over 80° F. the weather is exceedingly trying and should it reach up to 88° F., it is regarded as prejudicial to life.

Wet bulb registration above 80° F. may be regarded with suspicion, and correct readings over 88° F. are practically impossible.

The drier the atmosphere the greater will be the difference between the readings of the wet and dry bulbs. It may be as much as 30°, if there is very little moisture in the air, but if the air is fully charged to saturation point, there will be no evaporation, and both dry and wet bulb readings will be the same.

Mathematical tables are available by which from readings of the two thermometers humidities can be calculated, i.e. the percentage ratio between the amount of moisture present and the amount required to saturate the air at the prevailing dry bulb temperature.

Absolute Humidity.

The adjective "absolute" is less commonly used to qualify the humidity. This is also calculated from the readings of the wet and dry bulbs, and refers to the mass or actual amount of water vapour present in each unit volume of air. It is expressed in either so many grains per cubic foot or so many grammes per cubic metre of air, but no such statistical references are made in the attached tables under the humidity columns.

The warmer the air is, the more water vapour it will absorb and hold, and, for this reason, it will be noticed that, on the average, the New Guinea humidity figures are much higher than in cooler climates. The temperature to which unsaturated air is reduced before it becomes saturated, is termed the dew point or the temperature at which moisture forms in visible drops. This is usually the lowest temperature of the night.

Dew readily collects on grass, metals or any good radiating surface and frequently appears on clear nights. Heavy dew is often a sign of good weather and the greater the difference between the wet and dry bulb thermometers, the greater are the chances of the weather being fine. It might be mentioned that the moisture which forms the dew is sometimes derived from the transpiration of plants, and thus in the mornings slight moisture may be seen condensed on the leaves of plants. Many New Guinea plants have particular adaptions for transpiration of moisture, while their flowers are so formed as to protect them from the effects of excessive moisture.

The average relative humidity is a most important factor in the growth of plant life and especially for such crops as sugar, tobacco, &c.

Observation of the behaviour of humidity is of importance to planters when drying their copra. For instance, where copra driers are situated near, or in, a valley the saturated cool night breeze drifting down the valleys makes drying extremely difficult.

Copra may have been thoroughly dried, but where the humidity is high, the copra will absorb a certain amount of moisture during the night and dry out during the heat of the day. In such situations, it is better to bag the copra later in the day when the atmosphere is usually drier than in the early morning when humidity is often greatest.

From observations taken over a period of years at five main coastal stations throughout the Territory, the average relative humidity is 81 per cent. at 9 a.m., 75 per cent. at 3 p.m. and 88 per cent. for 9 p.m. readings.

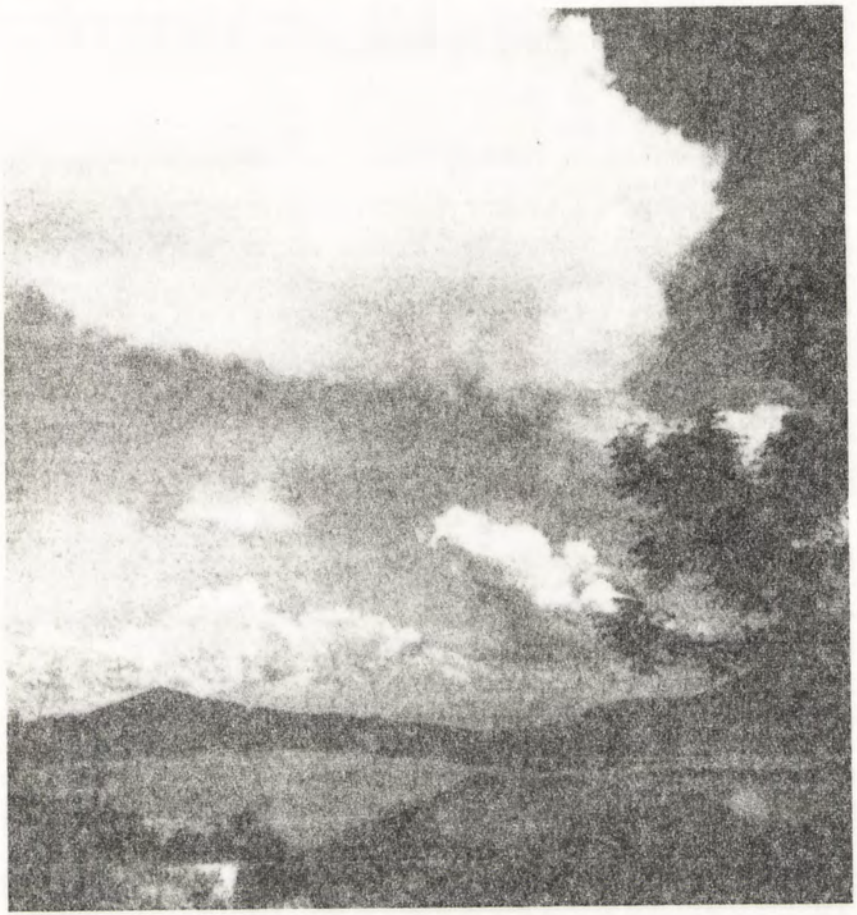
When the air movement is held in check by the dense virgin bush or jungle as in many parts of the Territory, the relative humidity is likely to be higher

than the previously quoted humidity figures, and on the highlands and plain country, it would doubtless be lower on the average.

Other Local Climatic Influences.

Forests.

Forests exert a marked local effect on climate as the sun's rays cannot reach the ground through the dense foliage which attracts the cool and denser vapours.



Cumulus Clouds over Rabaul taken from Taliligap.

If the forests are cleared, the atmosphere in such recently exposed places becomes warmer and drier. This fact was pointed out in this *Gazette* (vol. 4, No. 1), when discussing rainfall and forests.[2] Of course a similar warming and drying effect is noticeable after the drainage of swampy land; should the soil be of a sandy nature, it will be noticeably hotter than in clay country.

Aspect.

A southern and eastern aspect is usually cooler and more moist than a situation with a northerly and western one—a feature with which architects and horticulturists are often concerned.

In hilly country the lie of the land will have a marked effect on the climate. In the narrow valleys the side having the most shade may be cool and moist, while the opposite side would probably be warm and dry, thus causing an appreciable difference in climatic conditions between places relatively nearby.(7)

Some plantations and parts of plantations, for instance, have been suspected of receiving too much rainfall and too little sunshine to be payable propositions.

Sheltered situations will have a different climate from places exposed to the wind and weather, but if desired this defect can usually be controlled by the use of wind-breaks, as explained in previous notes on rainfall, which appeared in Vol. 4, No. 1 of this *Gazette*.(2)

Changes in climate are presumed to occur in isolated instances. History shows for instance the change in the eastern portion of the Sahara where the orchards and cereal fields of Carthage at one time covered hundreds of square miles; now there is only desert.

The department is grateful to those stations that have regularly submitted rainfall figures which have enabled the compilation of the rainfall map appearing in this issue.

This office would welcome, in addition to rainfall statistics, such particulars as pressures, temperature, moisture, cloudiness, sunshine, wind direction and velocity and visibility. It is the state of these meteorological elements over a considerable period of time which is required to complete a picture of the climate of any particular place and region. In fact, without a statistical treatment of such collated information, the latest science of long-range forecasting will be impossible.

As illustration of usefulness of an isolated type of information, weather bureaux have co-opted the services of air liners to give weather conditions and especially temperatures encountered at various heights to assist in forecasting, and the spread of existing weather conditions. From both an agricultural and health point of view, actual climatic conditions have a great bearing on the incidence of disease, whether of humans, animals or plants. In short, the principal factor controlling all growth life is climate.

Apart from illuminating statistical facts such as compiled from the attached climatological tables, observers who care to follow this subject will obtain an aesthetic delight from a study of changing weather phenomena, and to cite Ruskin—

> It (meteorology) is a science of the pure air, and the bright heaven; its thoughts are amidst the loveliest of creation; it leads the mind, as well as the eye, to the morning mist, and the noon-day glory and the twilight cloud—to the purple peace of the mountain heaven—to the cloudy repose of the green valley; now expiating in the silence of the stormless aether—now on the rushing of the wings of the wind. It is indeed a knowledge, which must be felt to be, in its very essence, full of the soul of the beautiful.

REFERENCES.

(1) Ballot, Professor Buys, quoted by the *Meteorological Glossary*, Meteorological Office, London.
(2) Challis, B., Rainfall Notes. *New Guinea Agricultural Gazette*, vol. 4, No. 1, p. 39.
(3) *Australian Meteorological Observer's Hand-book*, 1925.
(4) Humboldt—Quoted by Nicholls and Holland—*A Text Book of Tropical Agriculture*.
(5) Lee, D. H. K., *Queensland Agricultural Journal—The Tropics and Man*.
(6) The *Meteorological Glossary*, Meteorological Office, London.
(7) *A Text Book of Tropical Agriculture*, by Nicholls, H. A., and Holland, J. H., Pub. Macmillan and Co., Ltd., London, 1929.
(8) *New Guinea Agricultural Gazette*, vol. 5, No. 1, p. 66 (Rabaul Climatological Data).

METEOROLOGICAL RECORDS.

STATION—AIYURA. DISTRICT—MADANG.

Subject—Temperature and Humidity.

(145° 55′ E., 6° 20′ S. 5,875 feet above sea-level.)

1938—Month.	Mean Temperature of.			Mean Humidity of— 9 a.m. only.	1938.		1938.	
	Maximum.	Minimum.	Monthly.		Highest maximum.	Date.	Lowest minimum.	Date.
	°F.	°F.	°F.	%	°F.		°F.	
January ..	..	59.5	..	83	..	..	57.5	17th
February ..	..	59.5	..	83	..	..	58.6	22nd
March ..	..	59.0	..	83	..	..	56.6	16th
April ..	..	58.8	..	89	..	..	54.1	30th
May ..	..	56.9	..	89	..	..	53.6	25th
June ..	..	55.3	..	83	..	..	51.1	20th
July ..	..	55.0	..	88	..	..	52.8	25th
August ..	..	54.8	..	94	..	..	52.2	18th
September..	65.8	55.7	60.7	78	68.4	23rd	51.8	14th
October ..	66.1	56.9	61.5	94	67.9	24th	52.9	26th
November..	68.2	58.1	63.1	89	71.8	17th	54.9	5th
December ..	68.1	58.2	63.1	89	70.2	25th	54.5	12th
Average ..	..	57.3	..	87	..	..	..	..
Extremes ..	..	54.8 (Aug.)	..	94 (Aug. and (Oct.)	..	..	51.1	20/6/38

Mean Minimum Temperature for 1938=57.3 °F.

Mean Humidity (9 a.m.) for 1938=87%.

METEOROLOGICAL RECORDS.

STATION—AIYURA. DISTRICT—MADANG.

Subject—Rainfall.

(145° 55′ E., 6° 20′ S. 5,875 feet above sea-level.)

Month.	1938, monthly rainfall.	Monthly average rainfall since 1933.	1938.		Greatest monthly rainfall since 1933.	Year.	Least monthly rainfall since 1933.	Year.	1938, monthly wet-days.	Wet-days monthly average since 1933.	Amounts of clouds mean of 9 a.m. only.
			Greatest fall in 24 hours.	Date.							
	Inches.	Inches.	Inches.		Inches.		Inches.		Days.	Days.	
January	7.31	6.18	1.65	27th	7.98	1936	2.89	1934	22	21.3	5.1
February	9.65	7.40	2.28	10th	9.65	1938	3.24	1934	18	22.3	6.3
March ..	8.30	9.37	1.88	11th	11.36	1936	8.30	1938	16	20.7	4.9
April ..	7.46	7.19	1.26	5th	14.21	1935	4.38	1937	16	16.5	6.3
May ..	3.18	4.24	0.76	18th	7.73	1935	1.11	1936	17	16.2	6.3
June ..	2.31	6.44	0.44	10th	26.39	1934	0.77	1935	16	13.0	5.9
July ..	2.04	3.43	0.50	21st	4.83	1934	1.65	1936	13	16.5	4.9
August ..	1.45	3.98	0.23	6th	7.71	1933	1.45	1938	14	14.7	6.7
September	6.95	4.92	1.71	3rd	6.95	1938	2.98	1933	22	18.0	7.7
October..	10.45	5.92	2.30	15th	10.45	1938	2.96	1935	22	15.3	6.7
November	5.39	5.95	1.21	26th	12.53	1933	5.27	1936	18	15.7	6.0
December	7.84	7.60	1.03	12th	15.80	1934	3.64	1935	22	19.3	6.6
Average..	6.03	6.05	..	..	..	..	..	..	18	17.5	6.1
Extremes	10.45 (Oct.)	9.37 (Mar.)	2.30 (Oct.)	15th	26.39 (June)	1934	0.77 (June)	1935	22 (Jan., Sept., Oct., Dec.)	22.3 (Feb.)	7.7 (Sept.)

Rainfall for 1938=72.33 inches.

Average Annual Rainfall since 1933=72.62 inches.

METEOROLOGICAL RECORDS.

STATION—BULOLO. DISTRICT—MOROBE.

Subject—Temperature and Humidity.

(146° 39′ E., 7° 11′ S. 2,200 feet above sea-level.)

1938—Month.	Mean Temperature of.			Mean Humidity of—	1938.		1938.	
	Maximum.	Minimum.	Monthly.	9 a.m. only.	Highest maximum.	Date.	Lowest minimum.	Date.
	°F.	°F.	°F.	%	°F.		°F.	
January ..	89.7	68.8	79.2	81	95.2	20th	65.1	4th
February ..	88.5	68.8	78.6	86	92.0	2nd	62.9	28th
March ..	89.0	68.1	78.5	81	92.5	17th	63.0	28th
April ..	89.6	69.2	79.4	77	91.8	14th	65.0	8th
May ..	86.1	67.4	76.7	81	89.5	8th	61.4	27th
June ..	85.0	66.9	75.9	76	89.6	3rd	62.1	2nd
July ..	85.6	64.8	75.2	68	91.9	3rd	59.6	2nd
August ..	84.5	64.2	74.3	72	92.0	25th	57.9	17th
September ..	86.1	67.3	76.7	81	91.5	14th	61.8	15th
October ..	87.5	67.1	77.3	77	92.5	28th	61.9	24th
November ..	89.2	68.4	78.8	77	93.2	6th	60.8	18th
December ..	88.6	68.7	78.6	81	92.5	16th	62.5	21st
Average ..	87.5	67.5	77.4	78.2	..	..	..	..
Extremes ..	89.7 (Jan.)	64.2 (Aug.)	79.4 (Apr.)	86 (Feb.)	95.2	20/1/38	57.9	17/8/38

Mean Temperature for 1938=77.4 °F.
Mean Humidity (9 a.m.) for 1938=78.2%.

METEOROLOGICAL RECORDS.

STATION—BULOLO. DISTRICT—MOROBE.

Subject—Rainfall.

(146° 39′ E., 7° 11′ S. 2,200 feet above sea-level.

Month.	1938, monthly rainfall.	Monthly average rainfall since 1931.	1938.		Greatest monthly rainfall since 1931.	Year.	Least monthly rainfall since 1931.	Year.	1938, monthly wet-days.	Wet-days monthly average since 1931.	Amounts of clouds mean of 9 a.m. only.
			Greatest fall in 24 hours.	Date.							
	Inches.	Inches.	Inches.		Inches.		Inches.		Days.	Days.	
January	8.65	4.71	1.69	3rd	8.89	1931	1.40	1933	17	13.6	7.0
February	3.05	3.89	0.76	8th	6.15	1934	1.67	1931	10	11.5	7.0
March ..	6.29	6.36	1.52	8th	11.54	1931	3.16	1935	12	14.8	7.9
April ..	4.41	5.39	1.35	22nd	8.75	1933	3.15	1937	8	12.9	5.5
May ..	3.10	3.56	1.05	13th	7.92	1937	1.24	1933	12	12.2	6.0
June ..	3.28	2.38	0.70	9th	4.66	1932	0.85	1931	15	12.1	5.4
July ..	1.64	3.66	0.51	23rd	6.10	1937	1.64	1938	7	14.8	4.6
August ..	1.73	4.52	0.70	10th	8.91	1937	1.73	1938	7	14.9	5.6
September	4.46	4.56	1.18	24th	6.87	1936	1.97	1933	17	15.8	6.7
October..	5.92	4.71	1.10	1st	8.64	1933	1.69	1932	14	13.8	5.7
November	6.11	6.29	2.48	24th	9.70	1933	4.35	1934	12	15.2	6.0
December	4.84	5.59	0.73	29th	10.84	1934	3.60	1936	16	14.7	6.2
Average..	4.45	4.64	..	..	..	..	..	..	12.2	13.9	6.1
Extremes	8.65 (Jan.)	6.36 (Mar.)	2.48	24/11/38	11.54 (Mar.)	1931	0.85 (June)	1931	17 (Jan. and (Sept.)	15.8 (Sept.)	7.9 (Mar.)

Rainfall for 1938=53.48 inches.
Average Annual Rainfall since 1931=55.62 inches.

METEOROLOGICAL RECORDS.

STATION—KAVIENG. DISTRICT—NEW IRELAND.

Subject—Temperature and Humidity.

(2° 34′ S., 150° 49′ E. North-west coast of New Ireland. 10 feet above sea-level.)

1938—Month.	Mean temperature of.			Mean humidity of.			1938.		1938.	
	Maximum.	Minimum.	Monthly.	9 a.m.	3 p.m.	Monthly.	Highest maximum.	Date.	Lowest minimum.	Date.
	°F.	°F.	°F.	%	%	%	°F.		°F.	
January ..	89.5	78.0	83.7	91	87	89	94.0	23rd	72.0	24th
February..	92.0	79.9	85.9	91	83	87	98.0	25th	72.1	16th
March ..	91.4	78.5	84.9	91	87	89	99.0	3rd	74.0	14th
April ..	90.8	78.7	84.7	91	91	91	97.0	20th	76.0	21st
May ..	91.2	78.5	84.8	95	91	93	94.0	14th	76.0	5th
June ..	89.1	77.9	83.5	91	87	89	92.0	15th	73.0	29th
July ..	90.4	79.6	85.0	91	91	91	92.2	18th	74.0	13th
August ..	92.3	81.0	86.6	87	88	87.5	98.0	31st	77.0	23rd
September	93.6	80.3	86.9	91	92	91.5	98.0	1st	75.0	21st
October ..	91.2	78.5	84.8	91	92	91.5	98.0	6th	70.0	30th
November	89.7	77.5	83.6	87	87	87	94.0	2nd	72.0	18th
December	88.0	77.2	82.6	87	87	87	92.0	22nd	72.0	31st
Average ..	90.8	78.8	84.8	90.3	88.7	89.5	..	..	..	..
Extremes	93.6 (Sept.)	77.2 (Dec.)	86.9 (Sept.)	95 (May)	92 (Sept. and Oct.)	93 (May)	99.0	3/3/38	70.0	30/10/38

Mean Temperature for 1938=84.8 °F.
Mean Humidity for 1938=89.5%.

METEOROLOGICAL RECORDS.

STATION—KAVIENG. DISTRICT—NEW IRELAND.

Subject—Rainfall.

(2° 34′ S., 150° 49′ E. North-west Coast of New Ireland. 10 feet above sea-level.)

Month.	1938, monthly rainfall.	Monthly average rainfall since 1917.	1938.		Greatest monthly rainfall since 1917.	Year.	Least monthly rainfall since 1917.	Year.	1938, monthly wet-days.	Wet-days monthly average since 1917.	Amounts of clouds mean of 9 a.m., 3 p.m., 9 p.m.
			Greatest fall in 24 hours.	Date.							
	Inches.	Inches.	Inches.		Inches.		Inches.		Days.	Days.	
January	24.20	12.02	3.40	28th	30.07	1923	2.78	1934–35	19	16.9	5.3
February	11.52	11.33	3.35	16th	20.37	1924	1.40	1917	20	16.6	3.7
March ..	10.07	11.48	2.65	18th	25.83	1920	4.53	1917	19	17.4	2.4
April ..	8.60	11.26	1.52	20th	26.46	1921	4.31	1924	14	16.2	2.4
May ..	4.31	10.19	1.62	31st	17.27	1931	4.31	1938	10	15.8	1.3
June ..	12.22	8.74	3.67	28th	19.80	1923	3.60	1924	15	15.5	3.6
July ..	6.21	9.25	2.59	1st	17.85	1929	3.61	1917	12	16.9	4.8
August ..	3.29	9.74	1.81	24th	24.57	1929	1.30	1924	10	16.5	3.6
September	2.00	7.32	0.97	10th	18.24	1934	1.63	1918	5	14.0	3.6
October..	5.96	8.95	2.33	8th	22.43	1928	0.87	1917	11	15.7	4.1
November	16.07	9.25	3.84	19th	19.24	1936	2.47	1917	18	15.5	5.5
December	15.02	10.67	2.30	30th	18.30	1929	3.68	1933	20	16.7	6.4
Average..	9.96	10.02	..	..	..	..	..	..	14.4	16.1	3.9
Extremes	24.20 (Jan.)	12.02 (Jan.)	3.84	19/11/38	30.07 (Jan.)	1923	0.87 (Oct.)	1917	20 (Feb. and Dec.)	17.4 (Mar.)	6.4 (Dec.)

Rainfall for 1938=119.47 inches.
Average Annual Rainfall since 1917=120.20 inches.

METEOROLOGICAL RECORDS.

STATION—KIETA. DISTRICT—KIETA.

Subject—Temperature and Humidity.

(6° 13′ S., 155° 39′ E. East Coast of Bougainville Island. 150 feet above sea-level.)

1938—Month.	Mean temperature of.			Mean humidity of.			1938.		1938.	
	Maximum.	Minimum.	Monthly.	9 a.m.	3 p.m.	Monthly.	Highest maximum.	Date.	Lowest minimum.	Date.
	°F.	°F.	°F.	%	%	%	°F.		°F.	
January ..	87.2	77.2	82.2	79	72	75.5	92.5	5th	75.5	23rd
February..	..	..	..	83	79	81.0	..	..	..	..
March ..	88.1	76.8	82.4	79	76	77.5	91.0	3rd	74.6	25th
April ..	88.4	75.9	82.1	76	79	77.5	90.9	11th	73.0	23rd
May ..	86.9	77.2	82.0	75	76	75.5	90.0	25th	73.0	2nd
June ..	86.2	76.3	81.2	83	75	79.0	90.8	11th	73.0	9th
July ..	86.4	75.4	80.9	78	69	73.5	89.0	4th	73.0	25th
August ..	87.0	79.2	83.1	79	72	75.5	89.0	27th	73.5	31st
September	86.7	76.0	81.3	79	76	77.5	91.0	5th	73.5	1st
October ..	86.9	77.1	82.0	79	76	77.5	90.5	21st	74.5	29th
November	86.0	76.3	81.1	75	76	75.5	90.0	3rd	75.0	28th
December	83.3	76.1	79.7	83	83	83.0	88.5	4th	74.0	4th
Average ..	86.7	76.7	81.6	79	75.8	77.4	..	..	..	..
Extremes	88.4 (April)	75.4 (July)	83.1 (Aug.)	83 (Feb, June and Dec.)	83 (Dec.)	83.0 (Dec.)	92.5	5/1/38	73.0	23/4/38 2/5/38 9/6/38 25/7/38

Mean Temperature for 1938=81.6 °F.
Mean Humidity for 1938=77.4%.

METEOROLOGICAL RECORDS.

STATION—KIETA. DISTRICT—KIETA.

Subject—Rainfall.

(6° 13′ S., 155° 39′ E. East Coast of Bougainville Island. 150 feet above sea-level.)

Month.	1938, monthly rainfall.	Monthly average rainfall since 1917.	1938.		Greatest monthly rainfall since 1917.	Year.	Least monthly rainfall since 1917.	Year.	1938 monthly wet days.	Wet-days monthly average since 1917.	Amounts of clouds mean of 9 a.m., 3 p.m., 9 p.m.
			Greatest fall in 24 hours.	Date.							
	Inches.	Inches.	Inches.		Inches.		Inches.		Days.	Days.	
January	7.64	10.65	2.88	23rd	19.52	1927	4.79	1925	13	18.7	7.3
February	11.34	10.58	2.82	14th	36.02	1927	2.79	1937	12	18.0	9.2
March ..	15.23	11.04	5.08	25th	33.67	1917	3.88	1926	23	18.8	7.1
April ..	16.63	11.56	4.57	6th	22.43	1925	3.93	1936	16	17.4	5.3
May ..	3.65	8.77	0.62	21st	15.13	1923	2.02	1924	16	16.8	5.7
June ..	4.72	8.57	0.68	9th	19.11	1920	2.49	1924	16	16.9	5.4
July ..	4.70	10.48	0.54	*	22.31	1921	4.89	1924	15	17.7	4.5
August ..	4.36	9.63	0.55	15th	20.29	1925	1.94	1922	20	15.8	5.2
September	6.76	8.83	1.54	19th	17.66	1924	1.65	1935	15	15.9	5.1
October..	4.02	9.67	0.54	25th	27.01	1928	4.11	1932	12	16.4	5.0
November	7.51	9.26	2.73	28th	15.69	1936	2.60	1930	15	15.8	6.2
December	11.89	9.17	2.37	1st	18.70	1921	1.33	1925	22	17.2	6.7
Average..	8.20	9.85	..	..	..	..	..	..	16.3	17.1	6.0
Extremes	16.63 (Apr.)	11.56 (Apr.)	5.08	25/3/38	36.02 (Feb.)	1927	1.33 (Dec.)	1925	23 (Mar.)	18.8 (Mar.)	9.2 (Feb.)

Rainfall for 1938=98.45 inches.
Average Annual Rainfall since 1917=118.21 inches.

* = 2nd, 8th and 25th July, 1938.

METEOROLOGICAL RECORDS.

STATION—MADANG. DISTRICT—MADANG.

Subject—Temperature and Humidity.

(5° 11′ S., 145° 48′ E. 15 feet above sea-level.)

1938—Month.	Mean temperature of.			Mean humidity of.			1938.		1938.	
	Maximum.	Minimum.	Monthly.	9 a.m.	3 p.m.	Monthly.	Highest maximum.	Date.	Lowest minimum.	Date.
	°F.	°F.	°F.	%	%	%	°F.		°F.	
January ..	88.0	73.7	80.8	83	72	77.5	94.0	17th	70.0	14th
February..	87.0	74.9	80.9	95	79	87.0	92.0	3rd	70.0	16th
March ..	84.1	74.6	79.3	87	75	81.0	86.5	28th	69.5	19th
April ..	84.4	74.1	79.2	83	75	79.0	87.5	11th	71.7	17th
May ..	84.5	74.3	79.4	83	75	79.0	86.8	9th	71.5	24th
June ..	84.0	73.5	78.7	91	75	83.0	86.5	8th	68.9	11th
July ..	83.9	72.9	78.4	95	75	85.0	85.7	8th	69.3	10th
August ..	84.8	74.2	79.5	91	75	83.0	86.8	28th	72.5	4th
September	83.1	74.1	78.6	91	79	85.0	86.2	16th	71.3	30th
October ..	83.3	73.5	78.4	91	79	85.0	86.1	19th	71.3	2nd
November	84.4	74.4	79.4	91	79	85.0	86.6	16th	70.0	4th
December	83.9	74.3	79.1	91	83	87.0	88.9	6th	72.3	27th
Average ..	84.6	74.0	79.3	89	77	83.0	..	..	..	..
Extremes	88.0 (Jan.)	72.9 (July)	80.9 (Feb.)	95 (Feb. and July)	83 (Dec.)	87.0 (Feb. and Dec.)	94.0	17/1/38	68.9	11/6/38

Mean Temperature for 1938=79.3 °F.
Mean Humidity for 1938=83%.

METEOROLOGICAL RECORDS.

STATION—MADANG. DISTRICT—MADANG.

Subject—Rainfall.

(5° 11′ S., 145° 48′ E. 15 feet above sea-level.)

Month.	1938, monthly rainfall.	Monthly average rainfall since 1917.	1938.		Greatest monthly rainfall since 1917.	Year.	Least monthly rainfall since 1917.	Year.	1938, monthly wet-days.	Wet-days monthly average since 1917.	Amounts of clouds mean of 9 a.m., 3 p.m., 9 p.m.
			Greatest fall in 24 hours.	Date.							
	Inches.	Inches.	Inches.		Inches.		Inches.		Days.	Days.	
January	19.72	12.39	4.57	5th	21.27	1935	0.10	1925	25	19.7	7.7
February	6.30	11.57	1.73	14th	24.24	1919	4.82	1925	18	17.7	8.5
March ..	17.69	15.04	5.81	19th	27.92	1919	4.95	1925	18	20.9	5.3
April ..	23.26	16.96	6.25	17th	31.20	1921	4.79	1936	19	20.4	5.3
May ..	9.65	14.79	3.55	17th	25.23	1935	6.77	1934	20	19.2	4.7
June ..	8.20	9.96	3.88	9th	27.65	1923	2.74	1931	22	17.1	4.0
July ..	14.04	7.82	3.07	18th	15.77	1930	1.65	1919	21	14.1	5.0
August ..	5.71	4.79	2.49	21st	14.95	1936	0.03	1919	18	9.5	5.5
September	17.38	5.89	3.80	30th	17.38	1938	0.06	1930	19	14.0	5.3
October..	14.76	9.75	2.15	29th	20.74	1920	2.97	1930	24	13.3	6.3
November	13.80	18.27	3.97	26th	20.85	1936	6.42	1918	18	16.5	8.3
December	12.14	14.16	1.69	8th	31.80	1927	4.41	1918	24	19.6	8.3
Average	13.55	11.78	..	..	..	..	..	..	20.5	16.8	6.2
Extremes	23.26 (Apr.)	18.27 (Nov.)	6.25	17/4/38	31.80 (Dec.)	1927	0.03 (Aug.)	1919	25 (Jan.)	20.9 (Mar.)	8.5 (Feb.)

Rainfall for 1938=162.65 inches.
Average Annual Rainfall since 1917=141.39 inches.

METEOROLOGICAL RECORDS.

STATION—LORENGAU. DISTRICT—MANUS.

Subject—Temperature and Humidity.

(2° 2′ S., 147° 19′ E., North Coast Manus. 20 feet above sea-level.)

1938—Month.	Mean temperature of.			Mean humidity of.			1938.		1938.	
	Maximum.	Minimum.	Monthly.	9 a.m.	3 p.m.	Monthly.	Highest maximum.	Date.	Lowest minimum.	Date.
	°F.	°F.	°F.	%	%	%	°F.		°F.	
January ..	86.7	74.1	80.4	87	76	81.5	91.0	23rd	71.5	12th
February..	86.9	74.0	80.4	87	83	85.0	89.5	5th	71.5	3rd
March ..	89.0	73.3	81.1	87	76	81.5	92.5	17th	71.0	29th
April ..	88.6	74.6	81.6	87	76	81.5	94.5	30th	73.0	29th
May ..	90.5	75.2	82.8	83	69	76.0	92.0	31st	73.0	17th
June ..	88.1	76.4	82.2	86	72	79.0	92.0	1st	73.5	1st
July ..	88.0	73.2	80.6	91	69	80.0	93.0	6th	68.0	8th
August ..	90.0	72.7	81.3	95	80	87.5	93.0	28th	71.5	11th
September	88.6	73.2	80.9	91	88	89.5	92.0	1st	71.0	15th
October ..	89.4	73.2	81.3	91	92	91.5	94.0	21st	70.5	4th
November	88.4	73.6	81.0	83	83	83.0	93.0	9th	71.0	1st
December	86.5	73.2	79.8	91	91	91.0	90.5	25th	71.0	13th
Average ..	88.4	73.9	81.1	88.3	79.6	83.9	..	..	..	..
Extremes	90.5 (May)	72.7 (Aug.)	82.8 (May)	95 (Aug.)	92 (Oct.)	91.5 (Oct.)	94.5	30/4/38	68.0	8/7/38

Mean Temperature for 1938=81.1 °F.
Mean Humidity for 1938=83.9%.

METEOROLOGICAL RECORDS.

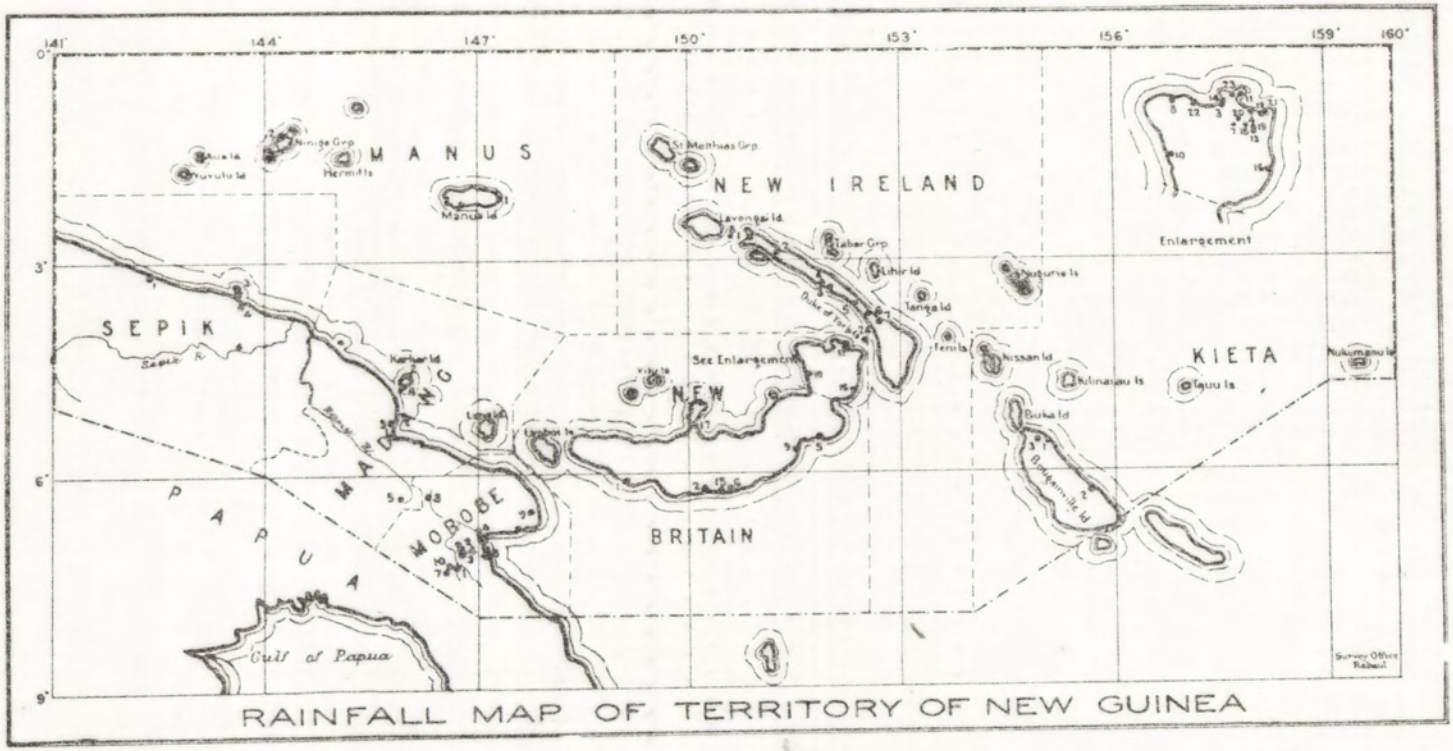
STATION—LORENGAU. DISTRICT—MANUS.

Subject—Rainfall.

(2° 2′ S., 147° 19′ E. North Coast Manus, 20 feet above sea-level.)

Month.	1938, monthly rainfall.	Monthly average rainfall since 1917.	1938.		Greatest monthly rainfall since 1917.	Year.	Least monthly rainfall since 1917.	Year.	1938, monthly wet-days.	Wet-days monthly average since 1917.	Amounts of clouds mean of 9 a.m., 3 p.m., 9 p.m.
			Greatest fall in 24 hours.	Date.							
	Inches.	Inches.	Inches.		Inches.		Inches.		Days.	Days.	
January	23.60	11.24	4.20	12th	23.60	1938	4.59	1925	21	18.4	7.8
February	7.53	11.36	3.56	17th	23.90	1933	0.24	1917	13	14.6	7.5
March ..	9.12	11.71	1.51	7th	17.25	1930	6.02	1926	16	18.7	6.7
April ..	12.68	14.17	3.20	7th	22.25	1919	3.45	1936	21	18.7	7.2
May ..	6.50	10.63	1.40	30th	15.01	1931	3.73	1924	12	18.4	5.5
June ..	10.50	13.27	2.91	9th	20.97	1932	5.03	1917	21	15.3	3.2
July ..	14.30	17.32	3.15	21st	33.46	1929	6.71	1933	19	20.1	2.5
August ..	7.61	16.30	1.72	18th	30.61	1937	1.51	1919	17	18.7	2.0
September	5.89	10.41	1.63	30th	19.09	1934	1.28	1919	17	16.6	3.1
October..	2.29	10.57	1.48	10th	21.56	1928	2.29	1938	7	16.8	2.6
November	11.58	11.15	2.42	18th	19.03	1936	2.93	1924	18	17.0	3.8
December	17.61	11.42	2.15	28th	26.56	1920	2.43	1925	22	18.1	4.9
Average..	10.77	12.46	..	..	..	..	..	..	17	17.6	4.7
Extremes	23.60 (Jan.)	17.32 (July)	4.20	12/1/38	33.46 (July)	1929	0.24 (Feb.)	1917	22 (Dec.)	20.1 (July)	7.8 (Jan.)

Rainfall for 1938=129.21 inches.
Average Annual Rainfall since 1917=149.55 inches.



RAINFALL MAP OF TERRITORY OF NEW GUINEA

TERRITORY OF NEW GUINEA.

ANNUAL RAINFALL AND MONTHLY AVERAGE (IN INCHES).

District—New Britain.

Number.	Locality.	1938 rainfall.	Years recorded.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
1	Arawe ..	162.82	5	3.35	3.90	7.45	7.89	16.15	20.38	26.34	29.29	29.83	14.88	8.71	5.13	173.30
2	Gasmata ..	172.98	19	5.43	5.79	7.28	10.44	24.75	28.99	36.90	45.15	35.77	20.28	12.83	7.70	241.31
3	Keravat ..	76.25	9	11.92	9.69	10.57	10.58	9.47	5.94	6.61	5.70	7.33	9.11	9.63	8.94	105.49
4	Kokopo ..	56.55	12	9.96	6.99	10.39	7.01	5.19	3.97	5.98	6.72	3.33	4.94	6.43	9.97	80.88
5	Kolai ..	137.13	6	6.47	8.15	8.28	9.88	18.15	24.30	28.69	35.46	21.05	10.50	13.41	7.84	192.18
6	Lindenhafen ..	194.41	19	7.22	6.40	6.06	11.01	27.31	33.94	39.39	44.63	34.93	19.52	13.51	8.27	252.19
7	Malaboga ..	76.45	1	11.12	5.91	11.70	8.63	1.61	3.12	1.12	0.32	5.44	8.88	8.07	10.53	76.45
8	Notre Mal ..	159.85	10	32.34	18.60	20.98	12.26	8.19	7.63	7.11	7.88	6.39	6.66	9.31	16.59	153.94
9	Palmalmal ..	107.78	7	7.30	8.75	8.43	10.59	19.96	15.76	29.33	41.64	16.82	13.76	9.79	9.02	191.15
10	Pondo ..	141.81	12	36.60	24.82	19.27	15.02	8.13	7.82	9.36	9.39	8.21	6.69	8.83	19.17	173.31
11	Rabaul ..	72.52	25	14.32	10.59	9.53	9.66	5.07	3.42	5.55	4.33	3.67	5.21	6.41	10.32	88.08
12	Rapopo ..	61.92	6	9.86	7.48	9.66	6.94	4.87	4.43	4.19	7.25	3.35	5.88	5.90	7.36	77.17
13	Ralabang ..	77.65	1	4.30	8.26	7.96	18.40	1.80	5.26	2.35	3.12	1.60	6.86	3.98	13.76	77.65
14	Raulawat ..	81.05	5	15.78	6.04	11.89	6.00	6.62	6.08	6.81	7.52	7.86	9.57	8.01	7.39	99.57
15	Ring Ring ..	213.92	4	6.14	5.30	8.62	7.34	26.49	28.96	44.15	47.96	47.22	26.55	19.47	8.59	276.79
16	Sum Sum ..	97.16	6	8.86	10.54	9.13	7.01	11.89	8.37	17.17	20.89	11.79	11.14	10.16	11.19	138.14
17	Talasea ..	152.65	21	32.74	29.38	24.06	18.87	7.52	5.07	5.25	4.77	5.36	7.95	11.06	19.66	171.69
18	Tobera ..	84.43	8	9.73	8.09	10.36	9.59	3.99	3.14	6.00	5.97	3.22	4.82	8.53	8.06	81.50
19	Tovarur ..	50.09	1	5.95	8.18	4.94	7.46	0.17	3.34	2.50	1.68	1.00	1.75	4.44	8.68	50.09
20	Ulatawa ..	68.29	3	10.00	9.13	10.26	5.15	3.98	3.15	3.43	8.54	3.93	6.84	9.13	9.26	82.90
21	Ulaveo ..	60.71	1	8.28	6.21	4.52	11.82	1.93	7.84	3.73	0.48	0.61	3.12	4.18	7.99	60.71
22	Vunalama ..	73.22	1	12.77	4.27	6.85	14.22	0.33	4.74	1.19	3.62	2.64	4.48	9.14	8.97	73.22
23	Wangaramut ..	60.90	1	8.84	7.95	6.62	6.62	1.73	5.33	0.84	1.40	5.25	5.04	4.38	6.90	60.90
24	Watnabara ..	81.42	15	13.11	10.74	10.38	10.79	7.71	8.54	10.91	10.99	8.48	9.65	8.30	9.45	119.05

TERRITORY OF NEW GUINEA.

ANNUAL RAINFALL AND MONTHLY AVERAGE (IN INCHES).

District and number.	Locality.	1938 rainfall.	Years recorded.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
New Ireland—																
1 ..	Kavieng ..	119.47	22	12.02	11.33	11.48	11.26	10.19	8.74	9.25	9.74	7.32	8.95	9.25	10.67	120.20
2 ..	Katu ..	121.91	3	23.13	13.25	21.57	9.11	5.78	5.22	6.39	11.15	8.71	9.17	13.17	14.24	140.89
3 ..	Kalili ..	123.17	15	22.63	13.73	16.25	10.60	10.49	11.91	19.16	16.98	15.29	16.15	13.84	20.80	187.83
4 ..	Kolube ..	151.73	1	23.41	28.06	18.42	12.71	4.32	11.91	5.98	5.40	0.86	1.79	14.79	24.08	151.73
5 ..	Komalu ..	72.58	1	2.40	11.65	13.51	5.59	4.20	8.80	5.74	1.57	1.08	2.65	5.05	10.34	72.58
6 ..	Matandeduk	116.63	3	21.71	12.60	17.87	5.55	3.68	2.96	2.43	9.21	4.06	4.86	12.94	17.23	115.10
7 ..	Namatanai	143.23	21	15.23	17.34	16.07	13.79	8.64	7.49	8.84	6.75	5.33	8.74	11.37	17.14	136.73
8 ..	Selapui ..	100.53	3	15.87	8.42	13.21	6.66	4.46	5.72	8.99	10.06	6.27	9.38	12.17	11.42	112.63
Kieta—																
1 ..	Hakau ..	100.57	3	9.53	17.09	14.10	8.93	7.52	5.21	8.12	6.44	6.90	7.18	10.65	6.14	107.81
2 ..	Kieta ..	98.45	22	10.65	10.58	11.04	11.56	8.77	8.57	10.48	9.63	8.83	9.67	9.26	9.17	118.21
3 ..	Raua ..	104.01	2	9.47	9.39	15.63	12.76	5.68	3.26	5.61	3.35	5.53	3.65	6.26	9.94	90.53
Manus—																
1 ..	Lorengau ..	129.21	21	11.24	11.36	11.71	14.17	10.63	13.27	17.32	16.30	10.41	10.57	11.15	11.42	149.55
2 ..	Pelleluhn ..	105.39	9	9.13	6.75	9.33	9.57	9.09	9.46	11.79	13.27	10.28	7.19	9.69	13.19	118.74
Morobe—																
1 ..	Edie Creek	89.85	9	8.16	7.50	12.05	11.06	6.94	4.63	6.04	6.46	8.67	8.74	11.17	13.31	104.73
2 ..	Baiune ..	70.72	5	5.46	6.24	8.46	4.60	4.27	2.54	4.50	4.45	5.93	5.48	9.80	6.74	68.47
3 ..	Bulolo ..	53.48	8	4.71	3.89	6.36	5.39	3.56	2.38	3.66	4.52	4.56	4.71	6.29	5.59	55.62
4 ..	Bulwa ..	71.93	4	7.09	5.89	6.90	5.18	4.84	1.81	3.79	3.86	5.43	5.27	8.09	5.29	63.44
5 ..	*Kaiyapit ..	93.87	10	9.51	8.61	13.60	12.14	5.22	2.03	2.64	2.59	3.36	5.98	7.95	11.52	85.15
6 ..	Lae ..	163.09	3	7.77	9.29	15.11	16.78	19.07	15.49	23.48	20.31	22.39	18.17	18.37	10.66	196.89
7 ..	Otibanda ..	66.68	3	3.54	5.97	4.38	4.91	6.16	3.12	4.65	3.51	5.55	7.31	7.05	3.70	59.85
8 ..	Salamaua ..	157.80	2	6.56	5.76	10.42	10.44	15.30	14.10	21.42	18.43	24.46	18.96	12.29	10.58	168.72
9 ..	†Sattleberg..	188.76	13	4.98	5.93	6.82	8.63	20.05	17.92	25.78	28.68	26.22	12.95	11.85	6.74	176.55
10 ..	Wau ..	62.05	1	5.34	3.70	6.52	4.28	4.66	5.71	1.78	3.83	5.15	3.81	8.27	9.00	62.05
Madang—																
1 ..	Erimahafen	132.94	1	14.50	10.83	23.68	12.32	9.31	2.39	5.07	2.12	22.31	8.37	6.65	15.39	132.94
2 ..	Kulili ..	164.63	4	17.13	19.17	20.32	11.65	10.36	8.22	7.36	5.47	7.69	10.30	14.95	17.60	150.22
3 ..	Madang ..	162.65	21	12.39	11.57	15.04	16.96	14.79	9.96	7.82	4.79	5.89	9.75	18.27	14.16	141.39
4 ..	†Urit Kurum	134.41	13	11.08	10.77	12.13	10.48	11.88	7.83	6.65	6.82	6.23	11.25	9.65	10.30	115.07
5 ..	Ramu Aiyura	72.33	5	6.18	7.40	9.37	7.19	4.24	6.44	3.43	3.98	4.92	5.95	7.60	9.33	76.03
Sepik—																
1 ..	Aitape ..	90.86	18	10.01	10.56	10.53	9.52	7.86	6.35	6.98	6.64	5.01	6.33	7.99	10.21	97.99
2 ..	Angoram ..	73.22	4	10.40	10.07	10.14	9.52	6.22	7.43	3.00	3.94	3.84	7.10	6.45	11.06	89.17
3 ..	Kairiru ..	142.28	1	15.40	9.24	9.20	6.12	14.00	9.85	8.37	10.17	17.79	18.14	10.10	13.90	142.28
4 ..	Wewak ..	87.86	10	5.71	3.49	5.66	8.02	7.91	8.14	9.84	5.78	9.72	9.16	6.93	6.97	87.33

* = Figures for 1937. † = Figures for 1936. 1938 figures missing.

THE TIMBER INDUSTRY IN THE TERRITORY OF NEW GUINEA.

(By J. L. d'Espeissis, B.Sc., B.Sc.For., Dip.For.)

The timber industry in the Territory is as yet only in the developmental stages. The *Timber Ordinance* 1922-1931 was repealed and a new ordinance, known as the *Forestry Ordinance* 1936-1937, came into force on the 15th September, 1937. Two forestry officers were appointed early in 1938, in order to assist in the administration of the new Ordinance.

The timber industry has had a rapid growth. Two or three years ago it was practically nil. Prior to the year 1933, there is no mention of timber in the listed exports; in the year 1933-34 timber in the log form was exported to the value of £180; in 1934-35, to the value of £705; in 1935-36, to the value of £360. For the year 1937-38, this figure jumped to £6,030 for logs, and £480 for sawn timber. The timber in logs, for this year, measured 3,103,996 super. feet. This was all exported to Australia—a little eventually finding its way onto overseas markets. Approximately 1,300,000 super. feet of sawn timber were produced in the Territory during the same period—this, however, was absorbed by the local market. At the end of 1938, there were some nine mills in operation, while approximately 23,500 hectares of Administration land was held under forest permits to cut and remove timber; while, in addition, a considerable amount of cutting was taking place on private property.

Due to a high tariff against sawn timber entering Australia, timber has been exported from this Territory mainly in the log form. Log export operations are confined, at present, to the island of New Britain, where, in addition, some five saw-mills are located, supplying the local market and an occasional small shipment of sawn timber for overseas. Apart from a few small mission saw-mills in various parts of the Territory, the only other timber operations of any importance are confined to the vicinity of Kavieng and Wau. These centres, however, supply only to local markets.

In the vicinity of Wau, several small saw-mills cutting in the best-known stand of hoop pine, klinkii pine and cedar in the Territory, supply—due to the obvious restrictions imposed by air transport—only the gold-mining industry centred about Wau. It is hoped, however, following the construction of a road to the coast, to start an export trade in these timbers, to be run in conjunction with a planting programme on a scale sufficiently large to ensure a sustained yield.

The industry has experienced numerous setbacks in the past, due to several causes, the most obvious of which was due to the shipment to Australia of logs of poor quality—no selection or discrimination having been exercised in this matter. The species exported were unknown in Australia, and often even untried in the Territory. Timber of types not then known to the "trade" were upon occasions dumped in Australia, and, due to lack of selection and care in handling, many of these logs were pipy, of bad shape and often riddled with borers. This did incalculable harm to the reputation of some of the best New Guinea species.

It is realized, I think, by the chief exporters that care must be taken to correct these mistakes. The value of creosote as a useful preventative against borer infection is beginning to be appreciated. The creosoting of all logs exported

from the Territory is now compulsory, unless special exemption has been obtained. Furthermore, facilities for export inspection by qualified officers are provided by the Administration for those who desire to avail themselves of this service. The importance of this inspection by an independent third party, between seller and buyer, cannot be stressed too strongly; for it will be necessary to live down the past by maintaining a high standard for the future. The regaining of this lost ground will be slow. It will be particularly important to study the requirements of the Australian and overseas markets, and regulate export to conform to demand, and not vice versa.

Australia's average annual softwood requirements amount to approximately 500,000,000 super. feet. Of this total she herself has supplied, during the last twelve years or so, an average of, approximately, 90,000,000 super. feet, which came almost entirely from Queensland, where it is now realized that the supply cannot last at this rate for many more years. It is apparent that an extra 90,000,000 super. feet will soon have to be procured from elsewhere. Promoters of this Queensland industry are eager to obtain hoop pine, or hoop pine substitutes, so they are naturally turning their eyes to New Guinea's hoop and klinkii pine resources as a means of supplying timber to enable them to carry on their established businesses. As already pointed out, the New Guinea pine stands are situated in the inaccessible highland regions of the mainland, where they will remain inaccessible until the construction of a road to the coast opens up this area.

Meanwhile, Erima (*Octomeles sumatrana*), a light-weight, light-coloured timber, from the readily accessible coastal forests, is proving to be a fairly general utility plywood proposition. Several other light-coloured, light-weight timbers from the coastal regions should also command a ready market, but they appear to be very susceptible to blue mould attack, which will debar them from export, until such time as a satisfactory technique for the prevention of blue stain in logs has been evolved, or tariff reductions allow the export of sawn timber on a profitable basis, when preventative measures could be taken here, immediately after sawing, to ensure that these timbers maintain their colour. Under such conditions, a new era should open up in the utilization of the coastal white scrub-woods.

Regarding hardwoods of the Territory, suitable for structural purposes, prospects are not so bright. It is most unlikely that an export trade to Australia will develop in these types; for Australia is the home of some of the world's best hardwoods. Apart from this the Territory's better hardwoods, i.e., kamarere (*Eucalyptus deglupta*) and kwila (*Afzelia bijuga*), do not occur in sufficiently large stands to warrant export. If the existing stands are not conserved for local use (for there is a definite need for durable hardwoods), it will be found in a few years that we will have to import all our building timbers from Australia—a quantity being already drawn from that source.

European markets have not been thoroughly explored, but there are indications that it may be possible to market in the United Kingdom a certain quantity of Taun (*Pometia pinnata*) as hardwood flooring. However, for medium-class hardwood timbers, such as this—of which there is no lack—the Far Eastern and South African markets are worthy of investigation. Considerable quantities of second-class Australian hardwoods are shipped to the Far East each year;

therefore, New Guinea—half way there—should be in an excellent position to supply this market. For those of our harder timbers possessing sufficient figure for cabinet work, there is hope that they may find favour in this guise in Australia and overseas.

Amongst those timbers suitable for cabinet work, there is one outstanding species, namely, laup, or New Guinea walnut (*Dracontomelum mangiferum*). The prospects regarding this species are particularly good. Once again, owing to the failing supplies of a Queensland timber—in this case, walnut—the "trade" now requires a new source of supply of this species, or else a satisfactory substitute, in order to meet the demand created by the popular Queensland walnut. This Territory is fortunate in having an excellent substitute for Queensland walnut in laup (*Dracontomelum mangiferum*). When carefully selected, it is a very handsome cabinet wood, of almost equal value as Queensland walnut. It is creating a considerable amount of interest in Australia and also in the United Kingdom and the United States of America. The market for this timber is already made; all that need now be done is to take sufficient care to maintain a satisfactory export standard in order to maintain it.

Other cabinet woods exist, but they will have to win popularity for themselves before they can become established on the markets of the world. This process will be slow and it can best be done by those firms in close touch with markets and having their own marketing organizations in Australia and overseas.

In view of this state of affairs, it is obvious, unfortunately, that selective logging—for the near future at least—is going to be a feature of the timber industry in this country, where, as is the case with most tropical rain forests, the mixture of species is a marked feature. This means that extraction costs will be relatively high. Also, due to the scattered and limited nature of felling operations, it will make the regeneration of economic species in exploited forests a difficult matter for the newly-created Forest Service. This, however, is only one of the many problems which have to be tackled and overcome. The future appears to hold considerable promise for the New Guinea timber trade; however, it does not do to be over-optimistic. It is necessary to face the fact that many difficulties will have to be overcome, and that it may be necessary to make haste slowly. However, with full co-operation between private enterprise and the Administration, these difficulties should prove to be by no means insuperable, and it should be possible to build up on a sound basis an industry which promises to rank timber with gold and copra, as being one of the Territory's foremost products.

SOME INVESTIGATIONS ON COCO-NUT DISEASES, ASSOCIATED WITH SOIL CONDITIONS IN NEW GUINEA.

(*R. E. P. Dwyer, B.Sc.Agr., Economic Botanist.*)

PART I.

Introduction.

In a article on the "Diseases of Coco-nuts (*Cocos nucifera*) in New Guinea" (see *New Guinea Agricultural Gazette*, Vol. 3, No. 1, April, 1937), (9), an account of the diseases due to fungi and physiological causes, so far recorded in this Territory, was presented. It was shown that chlorotic deficiency diseases of coco-nut palms which are associated with soil deficiency or soil exhaustion are very important in this country. Affected palms assume a sickly, yellowish-green colour, and the fronds gradually become shorter and fewer until eventually the few remaining fronds present a feathery, unhealthy appearance. The occurrences of this nature were fully described in the article quoted and are easily recognizable as due to soil deficiency. In the final stages tapering stem and general collapse of the bud or cabbage often results, primarily due to soil exhaustion. It is not proposed to deal with incidences of this type in the following discussion.

In the same issue several diseases which may be associated with unfavorable soil conditions and soil deficiency as main factors, together with other contributory causes, such as fungus attack, were described. These may be briefly listed as follows:—Chlorosis, tapering stem, die-back, bud-rot of certain kinds, nut-fall (some kinds), leaf-droop, leaf-break, tip-wither, frond-choke, drought wilt, production of leathery copra, and, finally, an "obscure physiological disease" found in New Ireland.

In describing the latter occurrence at some length (*see* pages 55 to 57 of the volume mentioned), it was stated in the general description that "one main distinguishing characteristic was the "wilting" of the central fronds of young palms in the affected areas".

It is the intention of this present article to publish some more detailed investigations on this "wilting" and "die-back" condition, and, also, to compare it with similar occurrences in other parts of the world. It should be mentioned that the owner of the plantation where this was most in evidence, and other planters in the vicinity, evinced considerable alarm over this disease. They believed, at first, that this condition was new to this Territory and was likely to spread on to adjoining properties, owing to the rapid appearance of the condition and the number of palms affected within a comparatively short time. For this reason, attention was paid to the attempts to solve the underlying causes of this "die-back" disease. The disease was investigated locally, both in the field and in the laboratory, during three separate seasons.

In an article on "The Fall of Mature Palms in New Guinea Plantations" (10), it was made clear that, from a practical stand-point, the study of soil profiles yields much information concerning the suitability of particular areas to coco-nut cultivation, even where chemical data is not available. It was also shown that coco-nuts can flourish and produce normally with a very

restricted root system, providing the surface soil is physically and chemically rich. Where the soils are poor and compacted, root restriction and water-logging will finally lead to deficiency symptoms and soil exhaustion becoming apparent.

In addition to the particular occurrence at Namatanai, some other derangements of the coco-nut palm, associated with unfavorable soil, sub-soil and water table conditions, together with inter-related climatic and nutritional factors, are described. In Part 1 of this article some derangements of young palms at Kokopo, New Britain, and from Bougainville Island also are described.

Description of the "Maturation Wilt" of Young Coco-nut Palms in New Ireland.

The palms on the plantation where this condition was recorded ranged from five to eight years old, and, in most instances, had just commenced to come into bearing. The general condition of the palms, in the areas affected, did not appear so good as in the surrounding areas. The trouble was found only in areas well away from the beach where the palms were planted at the wide spacings of 33 feet and 36 feet on the triangle system. The main area which was affected was situated in a hollow depression and comprised a total of about 600 palms, and numerous palms scattered over this area showed symptoms as described. There were a couple of other widely-separated areas which showed the condition. The plantation has a great proportion of its planted area on slopes exposed to the strong north-west winds. This would aid in the additional loss of water by transpiration (i.e., given off through the leaves), as the north-west season is the dry season on that coast.

Pronounced tip-withering occurred on the centre leaves of the affected palms, and some dying back was also seen on the outer leaves. On the back of the petioles (leaf stalks) of the crown leaves of the palms, pale brown streaks were seen. These sometimes showed up near the tip of the leaf or near the base, but, as a general rule, commenced about two-thirds of the way up from the base. The scattered lesions, although moist in appearance, were quite firm, but later they tended to spread and link up, becoming sunken below the general level of the outer surface of the midrib. Eventually the diseased portions split longitudinally, exposing the fibres after the ground tissues had fallen away, and the unhealthy parts become quite dry and hard.

A cross-section made after drying out had occurred showed a pale, sulphury-yellow layer immediately underneath the sunken tissue; this merged into a brown discolouration extending through the petiole almost to the inner surface. In longitudinal section the discoloured portion showed up as full- reddish-brown streaks. Such rotted portions were seen in some cases to extend below the fibrous tissue at the base of the leaves, but in no case did it appear to kill the palms. A tip-wither of the leaflets which extended from the top of the fronds almost to the base generally occurred concurrently with the stem-rotting mentioned.

Around the edges of the withered sections on the leaflets a distinct halo was noticed in some cases and the "die-back" from the tips was very distinctive. Pale areas with brown margins also appeared in the centre of the leaflets. The above symptoms only showed up on the fronds comprising the crown, while the older leaves were usually not affected.

It appeared that the palms affected were tall, very erect and close-growing, and not an open, robust type. They often presented a frond-choked appearance with the fibrous tissue bound tightly round the bases of the fronds. The only palms affected were those bearing nuts, or flowering before coming into bearing. The nuts from diseased palms showed an unhealthy, yellow colour. Examination of the roots showed no evidence of root disease.

The land prior to planting was under fairly heavy secondary growth and in the past had been used as native gardens. The land is undulating and rises gently from the beach. The soil on the beach and ridges is shallow and overlies coraline limestone. On the slopes and in the depressions the soil was much deeper and, in places, reached a depth of about 4 feet. In the profile the soil on the slopes showed a medium, dark-red, friable loam at the surface, which rapidly merged into a red, or chocolate, rather stiff, clayey sub-soil. A heavy growth of weeds and shrubs was allowed to grow over the area and amongst these Thurston grass, *Paspalum conjugatum,* and Kunai, *Imperata arundinacea,* were seen on the affected areas.

The fungus, *Pestalozzia palmarum,* or grey blight, and the insect, *Brontispa Froggatti,* were scattered widely in the plantation. The diseased palms seemed to be more plentiful where a heavy infestation of white fly, *Aleurodicus destructor,* and other unidentified scales were present. These were more plentiful in the hollows than on the ridges. Microscopical examination of diseased specimens failed to show any strongly parasitic organisms, although it did yield some interesting results.

Detailed investigations by Henderson and the author led to the belief that the condition was local and of physiological origin, so that it appeared likely that the natural soil conditions were at fault. One interesting feature concerning the topography was the presence of several large holes or depressions such as are often seen in country of coral origin. These extended well down into the underlying coral, and in one case a stream of water was running at the bottom of the declivity. It is believed that there is a subterranean passage and a large underground water channel underneath the area where the palms were affected. Here the rain water readily penetrated to the lower layers and was quickly carried away.

It appeared, also, that the roots of the palms showing the upright frond-choked condition had only penetrated the upper and more friable layers of soil while the roots of the stronger palms had penetrated deeper into the sub-soil (*see* diagrams, Figures 1 and 2). Practically all of the affected palms when pushed strongly could be rocked backwards and forwards, showing that the rooting was shallow and that this type of palm had a loose hold on the soil. The root-hold had been further reduced by the doubtful expedient of digging in deeply around the palms, so that many of the surface roots were cut. Whether this was also affected by original shallow planting in the first instance was not known, but appears likely. The appearance of the disease was associated with a pronounced spell of dry weather following on relatively heavy rains. It occurred, however, where the soil was apparently well suited to coco-nuts, although a little heavy in the sub-soil. The rainfall for the months of April, May, June and July, 1936, i.e., preceding the appearance of the disease, was just about half the average for those months at the nearest recording station, but the rainfall was said to be much lower than this at the plantation in question.

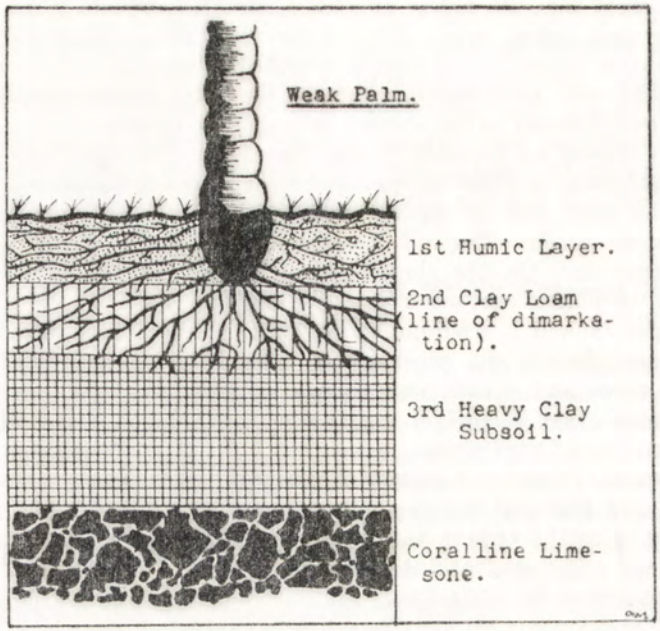


Figure 1.

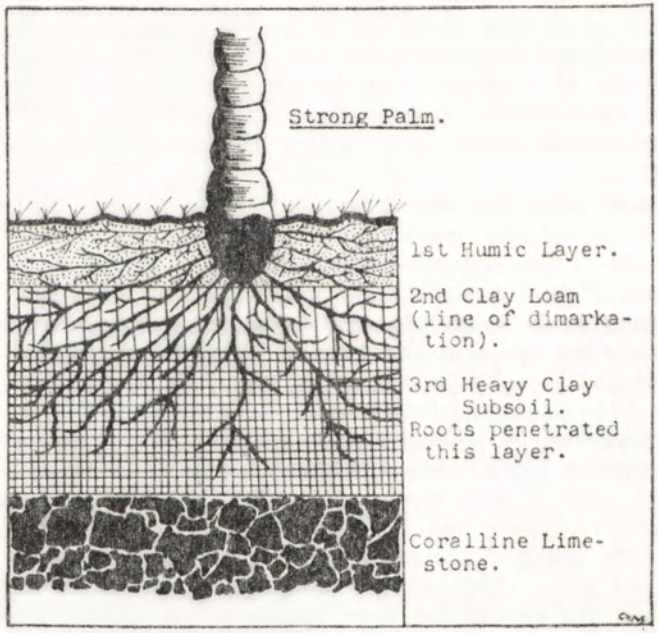


Figure 2.

The malady made an appearance when the palms were coming into bearing, which is a critical period in the life of the palm, when an additional strain is caused by increased water and nutritional requirements. This represents the change-over period from vegetative to productive phase.

During the dry period, shallow-rooting, rather weak palms were not able to obtain sufficient water and plant food to carry on normally, especially where the water could get away so easily. Further, insect attack and probably the effect of weakly-parasitic fungi had some effect when the vitality of these palms was lowered, and this caused some of the withering seen on the central leaves. Thus, there appeared to be a definite relationship between the incidence and severity of the disease and the type of palm.

It is a significant fact that recovery was coincident with the proper cleaning up of the place by cutting down high brush weeds, &c., and more particularly with the incidence of abundant rainfall. The white flies and various scale insects were very much less in evidence after the plantation was cleaned up and the rain occurred, which probably had some effect on the recovery of the palms.

The owner of this plantation became very concerned and drastically cut back many palms, in some cases, leaving only the central shoot, which led to the bud-rotting condition present, as this was probably associated with the entrance of secondary fungi and bacteria. Where the palms were cut back judiciously at a later interval and not too many fronds removed they made a good recovery.

Henderson observed that the streaking on the dorsal surface of the petioles (leaf stalks) was intimately connected with rotting tissues at the growing point. In the most seriously affected palms, a bud-rot was said to develop. It is not certain, however, how much of the sporadic bud-rotting which did occur was hastened by the drastic cutting back of the fronds of the affected palms, leading to the entrance and development of secondary organisms. It is most probable that, in some instances, bud-rotting did occur as a direct effect of physiological break-down, aided by secondary fungus and bacterial infection. The appearance of the diseased areas on the leaf stalks suggested physiological collapse of the cells due to faulty nutrition and failure of water supply, if, as it seemed, the fungi or bacteria isolated were not responsible for the longitudinal lesions seen. There were some minute boring larvae (apparently of a small moth or butterfly, but as they did not breed out they were unidentified) confined to some of the dead portions of the diseased streaks, where they were found in small, elongated tunnels, with their frass. Where any tendency of the bud to decay occurred, it was seen that it progressed typically from the leaf stalks inwards, which is apparently the reverse sequence to that found with the majority of bud-rot cases due to the *Phytopthora* fungus.

Where the ground was hoed over, in the dry season, all ground covers were removed, and the surface fibrous roots cut, which further exaggerated the drying out of the surface soil. Many feeding roots were destroyed on the young palms, with an already restricted root system, and this again diminished the water and nutrient supply to palms already suffering from deficiency. Such attempts at controlling the maturation wilt could only increase its effects, as was experienced.

The plantation on which the affection occurred was gradually planted over several years and the palms came into bearing roughly in the same order as the plantings were made.

Records show that the disease has appeared in the affected areas at approximately the same times in the corresponding seasons and in palms of similar age grouping in each of three years to 1937. At stated previously, none of the palms involved was more than eight years old.

The last visit to the plantation in connexion with this investigation was in August, 1937 (after the first description had been published). Then the disease again appeared in a patch of coco-nuts some distance away from the original focus, where the affected palms were also reaching the bearing stage in the dry season.

The owner had, ill-advisedly, cut the fronds so much that it was not possible to get suitable specimens of fronds showing streaking on the petioles for further examination.

Though the condition appeared at roughly the same period of the year, for successive years, as indicated above, it did not reappear later and no trouble was experienced during the year 1938 and up to June, 1939. It will be most interesting to see whether, in future years, it will appear in this plantation, under similar circumstances, in palms coming to the bearing stage. Though there is no sign of the disease at present, there is no guarantee that it will not occur again. The indications are very strong that palms which have passed the critical bearing stage on this property, and have recovered, or escaped the affection, are not liable to show a similar wilt again. The age factor must have an important interaction with other limiting factors present (such as water relationships, the type of soil, sub-soil and climate). As already pointed out, the plantings were made progressively, as time permitted, and in each year the disease occurred it was found in new areas.

Frond Choke.

The affected palms, in most instances, showed the condition of frond choke, which was also described in the article previously mentioned.[9]

In this case the terminal fronds tend to stand very erect and develop poorly. The outside leaves appear closely crowded around the growing point and their bases are held, or bound, together instead of growing free. The following fronds gradually become smaller and smaller as fresh ones appear, while the palm develops a sickly, yellow appearance and appears to lack vigour. As far as can be determined, there are no fungous pests responsible for this disease. It has been suggested that it is aggravated by close planting, unfavorable soil conditions, &c. Again there is a possibility that this is a virus disease, but as the condition is confined to definitely defined areas in many instances, this suggests some physiological derangement.

It appears that certain types of palms, which are very erect growers, are more liable to "frond choke" than others. Where this condition is present, it is wise to improve the cultural conditions, and, also, loosen the overhanging fibrous tissues at the bases of the constricted fronds.

The palms naturally tend to grow very upright where they are closely planted, and there is a dense canopy of closely intergrown fronds. This type of growth is also a common feature of replanted palms, growing under much older and taller palms, and it is an indication of light and, possibly, root competition. These

latter occurrences of palms showing upright growing fronds are similar in effect, but not due, to the same causes as where "frond choke" is met in areas of poorly vigorous palms of approximately the same age and development.

Presence of Necrotic Deficiency Spotting.

It was seen when visiting the plantation that the palm fronds in the whole affected area showed a yellowish or bronzed appearance. On closer examination, it was found that the coco-nut fronds in these areas were suffering from what appeared to be a "deficiency spotting" all over the leaflets (leaf pinnules) at the time the physiological wilt occurred.

The coco-nut leaves showed countless small brown or yellowish-brown spots. These abundant spots were close together and were usually rounded and surprisingly regular in outline. Their appearance suggested some form of "necrosis", as no organisms were found associated with the numerous small brownish spots present. Where *Pestalozzia* was found, the spots were large, more irregular and coalesced, thus presenting an altogether different appearance.

Some fronds showing deficiency spotting and derived from the affected area, at Namatanai, were collected and sent to England for examination and comment.

The report[1] by Professor Ashby (February, 1938) on the spotted coco-nut leaflets sent to him was as follows:—

The small spots appeared to be free from a fruiting fungus, but the large spots bore numerous pustules of *Pestalozzia* (or *Pestalotia*) *palmarum*, Cke., a fungus of very wide distribution on coco-nuts. Its parasitism on healthy leaves has not been proved; it is probably only able to infect leaves which are in ill health, due to some other cause. The very abundant, small spots are suggestive of the "Cadang Cadang" disease in the Philippines, mentioned in my previous letter.

At the present time, when a disease is thought to be of a physiological nature, one tends to think either of a virus or a soil deficiency, especially in some minor element (e.g., boron, manganese and zinc), especially if soil and subsoil conditions appear to be satisfactory in other respects, and there has been no very abnormal preceding weather.

We are still much in the dark about the change in the nutrient requirements of the coco-nut as it comes into bearing. It is likely to be one of the investigations in progress at the Coco-nut Research Station, Ceylon. A chemical analysis of the soil would bring out any deficiency in the available amount of one or other of the major essential elements (potash, phosphoric acid and lime). Volcanic soils, in particular, are liable to be deficient in availability of one or other of those elements for some crop-plants. In the annual report for 1936 of the East Malling Research Station, there are a number of interesting papers by Roach[23-24] and others, on injecting fruit trees, including leaves, with mineral substances for the detection of deficiencies. These methods might give interesting data if tried on the coco-nut.

It might be explained here that steps had already been taken to have the soils analysed as suggested in this report. The author had previously conducted injection experiments with coco-nuts on a plantation near Kokopo with twelve different substances and some interesting results were obtained with several of the substances used.

These preliminary tests on soil-deficiency problems are largely the sphere of a soil chemist, and only where they have any bearing on the nature of the disease in New Ireland are they discussed here.

To illustrate the possible effects of rare metal deficiency, such as boron, the symptoms described by Denniss, in *Science Progress*, 1937,[7] are given—

The most reliable diagnostic symptoms of boron deficiency in higher plants is *death* of the apical point of the stem. This is generally followed by stimulation in the growth of lateral buds, resulting in the formation of side shoots, which in turn die back at the

tip. Leaves of affected plants are commonly slightly thickened, often tend to curl and may become slightly chlorotic. Frequently, the petioles (leaf stalks) are noticeably brittle, and, in many cases, the plants fail to bloom or to set fruit.

He goes on to describe the histological symptoms, which include lack of full normal development, especially in the roots. Although the effects of boron have not yet been observed in coco-nuts, this description gives a good idea of what is not unlikely to happen here where rare metal deficiencies occur. Experiments already carried out have shown that iron compounds and such elements as copper sulphate, $CuSO_4$ (bluestone), in weak solution, do have a stimulating effect on chlorotic palms in this country.

It might be pointed out that sulphate of iron (ferrous sulphate, $FeSO_4$, $7H_2O$) has been used rather widely as a manure by one company on several plantations in the pumice belt near Rabaul, with good effect on the appearance and vigour of the palms. It does change the chlorotic appearance of the palms and causes their fronds to assume a more normal, healthy, green colour. It has been claimed that this quick effect is because the iron-sulphate assists in liberating certain plant foods in the soil[3] (i.e., purely due to catalysis). Its direct effect has, however, been indicated where the author carried out injection experiments with dilute solutions of the iron sulphate. The effect of iron was further confirmed where solid ferric citrate, $C_6H_5O_7$ (Fe_3) was injected into the chlorotic palms and gradually restored their colour. The direct tonic effect of ferric and other iron compounds on fruit trees and other plants, when applied in proper strength solutions, has also been amply demonstrated in other countries. When applied to the soil, it is almost certain that liberation of plant foods as well as the direct effect would occur.

Cadang Cadang Disease.

The Director of the Imperial Mycological Institute wrote as follows, which led us to make inquiries along the lines suggested:—

In the *Philippines Agriculturist*, vol. 26, No. 4, September, 1937, there is a short article by G. O. Ocfemia,[19] entitled "The Probable Nature of Cadang Cadang Disease of the Coco-nut." The symptoms described are suggestive of the "physiological disease" in New Ireland. Ocfemia, who has done some valuable work on virus diseases [bunchy top of Abaca (*Musa textilis*) and Fiji disease of sugar-cane], believes that the symptoms of the Cadang Cadang disease point to a virus causation.

Ocfemia, in reply to a letter from the present writer, stated that no further work had been carried out to determine the causal nature of the disease in question.

A condensed review of Ocfemia's article[19] is given from the *Review of Applied Mycology*, p. 108, February, 1938—

Coco-nuts on San Miguel Island (Philippines) were observed, in 1931, to be affected by a disease known locally as "Cadang Cadang" or growth failure and involving 25 per centum of the palms in some parts of the affected estate. The leaves were yellow and chlorotic, developing numerous yellowish, translucent spots, which turned orange-yellow. From a distance the crown of the affected trees appeared yellowish green. The pinnae were narrow and tended to bend over or break in the middle. The leaves gradually became smaller than those of the same age on healthy trees, and the blades of the pinnae of the middle leaves dried out, the leaves dropping prematurely. Infected plants were stunted and produced small, short leaves, closely bunched at the end of the trunk. The leaf-dwarfing was followed by gradual tapering of the trunk which finally appeared as a bare, pointed pole. As soon as the pinnae turned yellow, no further fruits were formed, though spathes were sometimes abundantly produced. The racemes (refers to flowers and flower stalks) dried out, but remained on the tree. No organism was found, but the characteristics of the disease are considered to indicate that a virus may be responsible.

It will be seen that there are several features in common with the disease from New Ireland, as, for example, the spotting and frond choking or bunching of the leaves. Nevertheless, the age factor and periodic appearance of the disease in palms which were coming to the bearing stage, and their subsequent recovery as well as absence of the marked tapering stem effects are points of difference which must be noted. It must be conceded also that physiological drought, manurial and rare metal deficiencies may induce similar symptoms to those described.

The occurrences in New Guinea as recorded in palms coming to maturity are closely related to those described by Dr. Jack,[15] and could be termed a "maturation wilt". There is little doubt in the present author's mind that the causes are closely related to those causing bronze wilt and other forms of coco-nut wilt.

Micro-Organisms associated with the Disease in New Ireland.

Plate and slope cultures of the organisms present in all parts of the affected palms were made. *Botryo-diplodia* spores associated with sickle-shaped spores of *Fusarium* spp. were seen. On all the cultures made, a very short bacteria was present which formed whitish colonies, later turning pink in the agar. This bacteria formed a slime (zooglœa) and did not infect the wounded leaves of very young palms.

A species of eelworm was found, associated with the diseased tissue of the leaf stalks, but only a very few colonies were seen. Specimens were prepared and sent to the Imperial Bureau of Parasitology, where Dr. Goodey identified the species as *Cephalobus rigidus*, which is a non-parasitic, saprophagous species of eelworm, commonly occurring in soil, on herbage and in decaying organic matter, and hence was not the cause of the petiole lesions.

Professor Ashby, in referring to the symptoms described (*New Guinea Agricultural Gazette*, vol. 3, No. 1, p. 55), said that "it is possible that the saprogenous *Cephalobus rigidus* might have followed a parasitic nematode. He suggested that "it might be desirable to examine the internal tissues of leaf stalks of leaves younger than those showing external symptoms (dark, depressed streaks and withering)". No parasitic species were, however, isolated after a long and careful search.

Simmonds[27] in 1925 described a form of "bud-rot" possibly due to nematode worms, from Fiji, but, unfortunately, they were apparently not identified. He recorded that "on one occasion a palm was found in Fiji, showing certain symptoms of 'bud-rot', but differing from the typical form in that the central leaf had not wilted and fallen over. Nematode worms were found to be present in vast numbers and were traced from a spot on one of the leaves to the central bud. They seemed in this instance to be the actual causal organisms". It is a pity that it was not determined whether this was a parasitic, or saprophytic species, as the latter would only feed on tissues killed from other causes.

Professor Ashby, Director of the Imperial Mycological Institute,[1] kindly investigated a number of slides, specimens stored in spirit, and cultures forwarded to him.

The following organisms were identified:—

What appeared to be *Aerobacter aerogenes* (Esch.) Cast. Chalm.=(*Bacterium aerogenes* Esch.); a slime-forming, non-motile, non-sporing rod, producing acid and gas clot in litmus milk. This is a bacterium of wide distribution in soil and

decaying plant tissue, but is not known to be pathogenic. There was another motile, rod-shaped bacteria (not identified) present, but the *Aerobacter* was the organism which turned up on platings.

Regarding the slide preparations, two scrapings from a nut showed the large septate, brown, striate pycnospores of *Botryo-diplodia theobromae* Pat. about 23-30 x 12-14 microns in size. The fungus is of world-wide distribution in the tropics on a great variety of crop-plants. It is a saprophyte or semi-parasitic entering through wounds, or through lesions caused by other fungi and capable of spreading rapidly in ripe fruits, or debilitated tissues. "Leaf-break" in Ceylon and elsewhere has been attributed to it.

In one scraping from a nut in which the pycnospores of *B. theobromæ* were present and in a scraping from a petiole which was made from a specimen in spirit, a hyphomycetous (*Fungi imperfecti*) fungus occurred with small, hyaline, elliptic conidia, on branched conidiophores. It could not be identified from the slide preparations, but might be recognizable in culture. A preparation from "sulphur-yellow tissue" showed 0-1 septate microconidia probably of a *Fusarium* spp., but no *chlamydospores* were detected.

In another slide (fungus and bacteria from a midrib, unsterilized culture) a fungus was present, in which the cells had separated into "Oidia"; it is probably a species of *Oospora*. Other slides contained bacteria, some being spore-forming. The specimens in spirit do not show anything characteristic of a known disease.

This definite statement by Professor Ashby that the isolated organisms were almost certainly not responsible for the primary trouble was very helpful in turning our attention from any organisms to the climate and soil conditions, where the affected palms were growing.

Nature of the Disease.

The scattered nature of the trouble and its sporadic appearance seemed to discount the fear that an infectious disease was present. It also appeared unlikely that if the disease were infectious to any degree, it would confine itself to palms at a certain stage of development, on a particular plantation.

Even in the earliest reports to the owner, it was stated that, "although fungi and other organisms were present, it was extremely doubtful whether any particular fungi were primarily responsible for the condition". This was borne out by the later investigations. It is well known that weakly, parasitic fungi, also insects, and other organisms have a much greater injurious effect on palms of poor vigour than on normal, healthy palms.

It appeared most likely from the investigations already outlined that the derangements displayed by the palms at Namatanai were almost undoubtedly of a physiological nature.

The necessity for soil analyses and for investigating any particular soil, water-table, climatic, or environmental conditions, likely to lead to upset of the nutritional functions of palms coming to the bearing stage, was also clearly indicated. It was obvious that any deficiency of the soil, especially in major nutrients, would greatly exaggerate any unfavorable environmental factors present.

The analyses carried out at the Waite Institute indicated a certain amount of potash deficiency in the soils where the affected palms were growing. Where the water and nutrient supply to the young palms was reduced by unfavorable soil

and water relationships, the availability of the potash to the palm would be still more lessened at the period of greatest demand. Where there is insufficient lime present, as was the case with the surface layer here, the potash would be given up still more slowly.

Particulars of Soil Samples.

The coco-nut palms which grow in the Namatanai district of New Ireland appear to flourish generally, although there are a few very old plantations in this area to indicate how they will fare when they reach an advanced age. The indications are, however, that they will last as long as in most districts here, despite the apparent shallow depth of soil, before coral is reached, in some places. The soils on the plantation under investigation are undoubtedly of a residual nature, being for most part derived, *in situ*, from uplifted coral. In some areas there is possible admixture of some top soil washed down from the high hills behind, but the soils are mainly of coralline derivation.

Profiles from three situations in the one plantation were submitted for analysis. In the "X" series, the hole was sunk on a fairly raised area, away from the foreshore, where the underlying coral was met closer to the surface.

In the "Y" series, the soil samples were taken from a spot lower down in a depression. In this position, the red, underlying sub-soil was deep and a hole had to be sunk several feet before any coral was reached.

The single sample "1Z" represents a different type of sub-soil which was met about 100 yards nearer the foothills than the position where the "X" series was obtained. This was more yellowish in colour, although the texture appeared much the same as the other sub-soils submitted.

The appearance of the affected palms and the accompanying symptoms, soil conditions, &c., have previously been described, as mentioned elsewhere.[9]

Report on Soil Samples from New Guinea.

(New Ireland District.)

*By J. S. Hosking.**

2. Soils from a privately owned plantation, Namatanai sub-district, New Ireland.

Two profiles and a further sub-soil sample from a privately-owned coco-nut plantation situated in the Namatanai sub-district on the island of New Ireland have been examined and the results are appended.

The two profiles from this coco-nut plantation are similar, and consist of red-brown extremely heavy clays throughout their whole depth. In the surface layers, which are darkened by organic matter, the clay contents are 62 and 79

* Of the Division of Soils, Council for Scientific and Industrial Research, located at the Waite Institute, South Australia.

per centum respectively and the content rises to about 90 per centum in the sub-soils. In profile "X" the clay sub-soil overlies a layer of soil, admixed with nearly 70 per centum of the parent coralline limestone. In the sub-soil "Z3" the colour is yellow to yellow-brown and the clay content also about 90 per centum. A coarse sand, fine sand, silt ratio, approximating to 1 : 3 : 6 for all the samples, indicates an essentially similar origin for the materials at all three profiles. The somewhat lower clay contents of the surface horizons show that some eluviation has taken place in both profiles.

Although the mechanical analyses of the soils (*see* Table 2) would appear to class the soils as heavy clays, their physical properties indicate that in the field they would act as much lighter soils in a similar manner to the red loams of eastern Australia.

The soils are acid in the surface and in the absence of limestone close to the surface, increase in acidity with depth. In the limestone layer, however, the soils become distinctly alkaline.

They are well supplied with both nitrogen and phosphoric acid, but potash is low throughout the profiles. The low values for potash, considering the high content of clay, show a further similarity to certain of the Australian red loams.

TABLE 2.—MECHANICAL ANALYSES AND CHEMICAL DATA FOR SOIL SAMPLES FROM A COCO-NUT PLANTATION, NAMATANAI SUB-DISTRICT, NEW IRELAND, TERRITORY OF NEW GUINEA.

Site.	X.				Y.			Z.
Sample Number.	1.	2.	3.	4.	1.	2.	3.	3.
Waite Institute Sample Number.	5390.	5391.	5392.	5393.	5395.	5396.	5397.	5398.
Depth in Inches.	..	..	..	..	..	..	..	..
	%	%	%	%	%	%	%	%
Coral limestone	..	..	..	63.7	..	..	..	..
Fine earth	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Coarse sand	1.0	0.7	0.3	0.2	2.4	1.0	0.2	0.2
Fine sand	3.5	2.0	1.1	0.5	8.4	3.5	1.0	1.6
Silt	7.3	5.0	3.7	0.8	20.1	10.1	2.2	3.0
Clay*	78.6	85.2	88.8	40.2	62.4	79.4	90.0	89.0
Loss on acid treatment ..	1.7	1.6	1.9	56.3	1.6	1.1	1.4	1.1
Moisture	5.5	5.1	5.3	2.5	5.7	5.6	6.0	6.1
Loss on ignition	19.1	17.2	16.1	..	16.5	15.5	14.5	13.2
Phosphoric acid P_2O_5.. ..	0.32	0.29	0.32	..	0.28	0.27	..	0.41
Potash† K_2O	0.03	0.03	0.04	..	0.04	0.04	..	0.06
Nitrogen N	0.27	0.25	0.15	0.10	0.22	0.15	0.14	0.10
Soil reaction pH	6.1	6.0	6.7	8.3	6.5	6.1	5.7	5.1

* Note high content. † Note low content.

"Frond Choke" and "Die-back" of Coco-nuts.

(Comments by Mr. Hosking.)

"It is unlikely that the diseases of coco-nuts at either the Kokopo Plantation, mentioned in the earlier report, or the particular plantation in Namatanai, which form the subject of this report, are the result of major plant nutrient deficiency, since, apart from the low content of potash in the latter soils, all soils examined are very well supplied with them. At the same time, the probable importance of minor elements must not be overlooked.

"After reading through the various reports by Mr. R. E. P. Dwyer, either published in the *New Guinea Agricultural Gazette* or forwarded with the soil samples, and, also, following a discussion of the problem with Mr. D. B. Adam, Plant Pathologist at the Waite Institute, it would appear that there is more than a chance resemblance between the 'frond choke' and 'die-back' described in New Guinea and the 'bronze-leaf wilt' described by Briton-Jones(4) (also Bain(2)), in Trinidad. [Their findings are detailed in a later section of this article.]

"The common feature is the general wilting of the young, shallow-rooting coco-nut palms after long spells of dry weather, with, usually, subsequent recovery following general rains.

"While this feature has usually been observed only on light soils, it does not preclude a similar occurrence on the Namatanai type of soil, despite its apparent heaviness.

"Water-holding capacity determinations indicate that under conditions which restrict or entirely prevent drainage, the soils from Kokopo will absorb from 60 to 100 per centum of their own weight of water, and the Namatanai soils examined from 65 to 90 per centum. The Kokopo soils are extremely porous and the sandy nature of the sub-soils allows the water to drain away rapidly. Dwyer has indicated in his report in the *New Guinea Agricultural Gazette*, 1938, Vol. 3, No. 1, p. 56, that the soils on this particular plantation at Namatanai are readily penetrated by water and the extremely cavernous nature of the underlying coralline limestone will, therefore, allow of just as rapid drainage as in the case of the lighter Kokopo soils. During periods of drought, therefore, both types of soil will dry out rapidly, especially in the surface layers, and the shallow-rooting young coco-nuts are, therefore, the more likely to be affected. Following heavy rains, the high water-holding capacities allow the soils to regain their normal moisture status and restore the water balance in the palm."

The present writer comments that it will be seen from the various reports, of which these analyses form a part, that these comments by Mr. Hosking are a valuable contribution towards the solution of the nature of the coco-nut disease at Namatanai. It is pointed out, however, that the pathological symptoms of the occurrence in New Ireland are much more complex than those at Kokopo, New Britain, and, undoubtedly, other factors are involved. There has been further work done on the occurrence from Namatanai, since the publication in the *New Guinea Agricultural Gazette* mentioned, and, in this regard, the comments of Professor Ashby, Director of the Imperial Mycological Institute,(1) also those of Dr. Ocfemia,(19) of the Philippine Islands, are most enlightening, and show that the issues are not so clear as it may appear.

The indication of a low percentage of potash in the Namatanai soils is most important in view of the conclusions of Bain, F. M.,(2) on his work on the causes of "bronze-leaf wilt" disease of the coco-nut palm in Trinidad, of which a *Review of Applied Mycology* review is given verbatim. It may be noted, however, that the disease in Trinidad has apparently not been always associated with coco-nut palms coming to the bearing stage, as seen in New Guinea at Kokopo, Namatanai, near Kieta on Bougainville Island, and elsewhere. The causes underlying the similar occurrences recorded by Jack in Malaya(15) may be closely related to what has been found in these present investigations.

As pointed out in the remarks on the plantation at Kokopo, the poor type of seed nuts used in that particular area, as well as the presence of "kunai" or "Alang Alang" (*Imperata arundinacea*), in the early stages, were contributing factors to the poor condition of the palms. Such circumstances rendered them more susceptible to any unfavorable soil and moisture relationships which may exist in times of drought, or when the palms are coming into bearing.

Particulars of Rainfall.

Unfortunately rainfall records have not been kept at the particular plantation from which the "maturation wilt" was recorded. Records kept at the Namatanai Government Station, which is only a few miles away, have, therefore, been consulted.

NAMATANAI RAINFALL.

(*See* Graph.)

——	Average for 21 years.	1936.	1937.	Rainfall wet season, average 21 years.	Rainfall dry season, average 21 years.
	Points.	Points.	Points.		
January	15.23	20.93	19.96	*	†
February	17.34	15.18	15.14	15.23	8.64
March	16.07	20.12	19.85	17.34	7.49
April	13.79	7.11	12.44	16.07	8.84
May	8.64	7.00	7.14	13.79	6.75
June	7.49	2.60	4.29	11.37	5.33
July	8.84	6.24	6.77	17.14	8.74
August	6.75	14.18	12.18	..	..
September	5.33	5.20	8.06	..	..
October	8.74	12.66	6.17	..	..
November	11.37	17.21	11.47	..	..
December	17.14	14.26	19.96	..	..
Total	136.73″	152.59″	143.43″	90.94″	45.79″

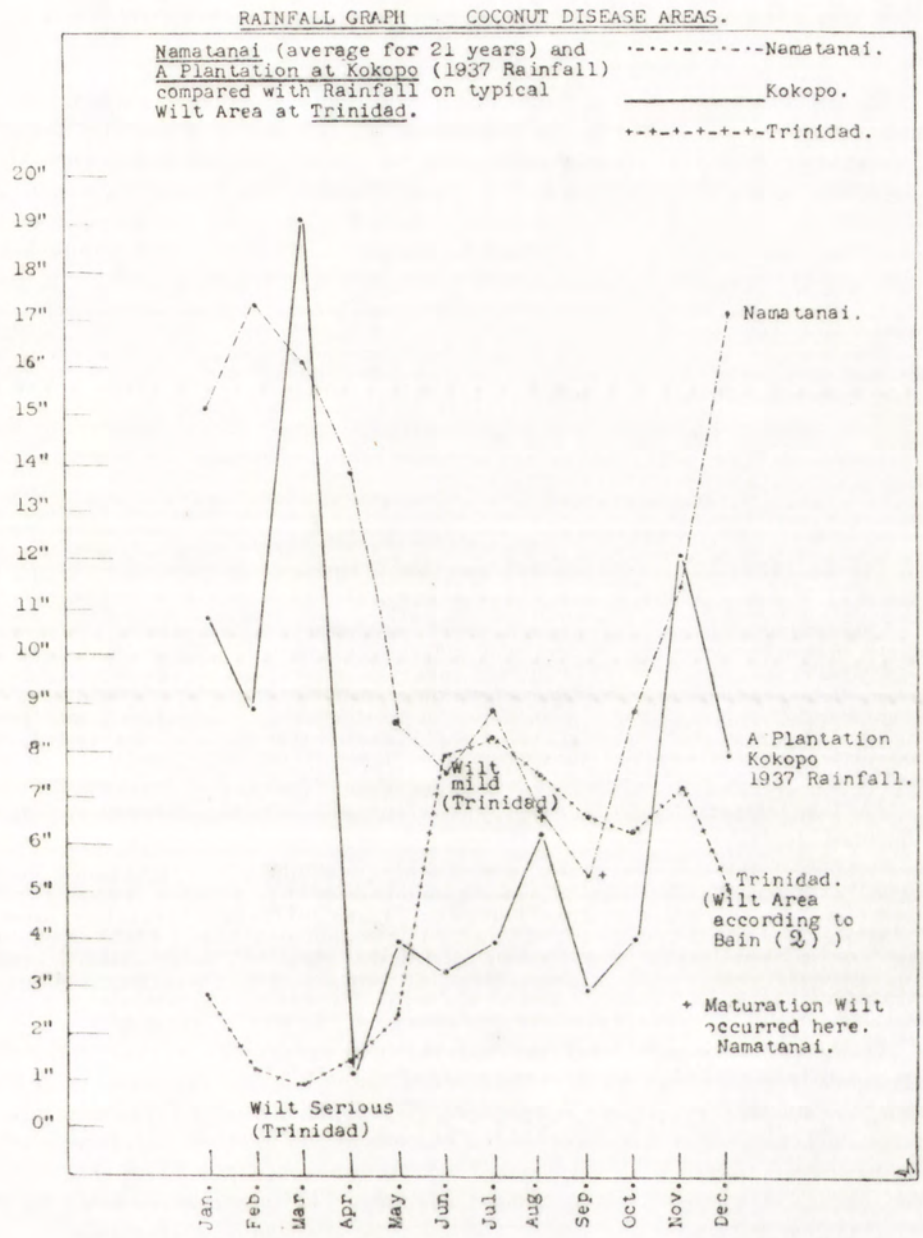
* November-April inclusive. † May-October inclusive.

It will be seen from the above records that the rainfall should be ample for coco-nuts. The wet period in this district is from November to April. There are six dry months of which the driest month is September—August ranking next. It will be noted that about twice the normal August rainfall was recorded in 1936 and 1937. Abnormal rainfall periods occurred in June, 1935, when 141 points of rain only were recorded, and curiously in June, 1936 (260 points) and June, 1937 (429 points) abnormally low rainfalls were again recorded. It will be seen that the rainfall for both these years was heavier than average, so that the contrast between the wettest and driest months is much greater than normal.

The contrasts between the wet and the dry seasons here are not nearly so great as that in the Madang District, or in parts of New Britain, for example, where sometimes eight times as much rain falls in the wet season as in the dry season. This was one of the considerations which led one to think the young palms would recover as soon as conditions become normal.

The fact that in New Guinea coco-nut palms are generally grown under much wetter rainfall conditions than those which prevail in many other parts of the world may have some bearing on the relatively limited occurrence of physiological, or true, drought wilts here. The land here has not been in cultivation for such long periods as in other parts of the world (such as the West Indies) and this would also greatly lessen the chances of wilts occurring here.

The rainfall distribution at Namatanai is compared (*see* graph) with that of a typical bronze wilt area in Trinidad, shown diagrammatically by Bain.[2]



It is seen that in the wet season he depicts, they would generally receive less rain than in a typical dry season at Namatanai. It would appear, however,

that, although the rainfall is much heavier, the fluctuations from the wet to the dry season are more marked in the latter instance. According to Bain, in a typical wilt area in Trinidad there is a marked dry season—February, March and April being particularly dry. From May onwards precipitation there is quite large (in comparison); the amount commences to decrease in December.

Earlier Incidences of the Disease.

It is pointed out that a "die-back" condition at maturity, as described, is not new to coco-nut palms in the Namatanai district, as was generally stated by the planters there. It was recorded from two plantations in 1923, when these plantations were at a comparatively young stage. The Entomologist of this Department, Mr. J. L. Froggatt, briefly described the same condition from the particular plantation under investigation on 26th November, 1934 (unpublished information), and the following remarks are quoted verbatim from his diary:—

"*Coco-nut Dieback.*—On the affected palms, one frond emerges and is apparently choked while the pinnae (leaf division) appear black where this occurs. The following frond becomes smaller and more choked and finally the folded pinnae appear as completely blackened. According to the owner, the palms may be killed if not cut back to the fresh tissue, above the cabbage, and tarred."

The palms were about four to five years old, and some were carrying their first nuts. He was also informed at the time of his visit, that the condition had been seen before on this same plantation.

Nature of the Disease at Namatanai.

In the 1936-37 Annual Report (*see* also League of Nations Report, p. 83, 1936-37),[17] the following notes are given:—

"Physiological diseases of coco-nuts were investigated at Namatanai. This rather obscure disease has been noticed here since 1923. It is apparently physiological and due to unsuitable soil and climatic conditions, while the palms are at the critical bearing period. Palms coming into the stage of maximum maturity have been noticed to suffer a physiological set-back, which often affects the production for upwards of two years. This has been noted here on several occasions, similar occurrences have been noted from Malaya,[15] and it is most prevalent on certain types of soil under particular climatic conditions."

In the Departmental Annual Report for 1937-38, the disease was again mentioned as follows:—

"Professor Ashby considered that, amongst other possibilities, the physiological disease present in coco-nuts just coming into bearing may be identical with the 'cadang cadang' disease described by Ocfemia in the Philippines,[19] and believed to be a virus disease. In August, 1937, this physiological 'set-back', as described in the last annual report, was again seen at Namatanai in palms reaching the bearing stage, but the fact that the palms soon recovered, when conditions were favorable, seems to show that the condition is physiological and is influenced by the extra demand for water and nutrients not being met under certain dry weather conditions on a heavy soil, at this critical stage."

It therefore appears that the reduced nutrient supply to the developing palms and fruits follows on the reduced water supply in the dry season at a time when the demand for nutrients is greatest. No doubt the effects were exaggerated by the deficiency of potash recorded. The contention that this may be a virus disease cannot afford to be overlooked, but the present author does not believe that this is the case in this particular instance. This opinion is based on the fact that the palms usually recover and do not often show a recurrence in the same area. There is little doubt that virus diseases are present on coco-nut palms here, as was recorded in the earlier article,[9] but, so far, no work has been done to indicate the importance of these types of diseases in coco-nuts.

Coco-nut Palms Showing "Frond Choke" and Bearing Poorly.

KOKOPO DISTRICT—NEW BRITAIN.

*(Report by the Economic Botanist.)**

On two distinct sections of an extensive plantation at Kokopo, New Britain, a large proportion of the coco-nut palms growing there presented a "frond-choked" appearance, and were bearing rather badly when visited first in November, 1937. The palms in these areas were either just past the first bearing stage, or, in other instances, had been bearing for no more than three years.

It is not uncommon for coco-nuts which have just reached the bearing stage, or have been in production for two or three years only, to show evidence of "frond choke" and similar disorders. In many parts of this Territory coco-nut palms have been noticed to suffer a physiological set-back at this stage, which often affects their production for two years or more. This has also been reported from Malaya, and is most prevalent on certain types of soils under particular climatic conditions. As for example, it has been seen on comparatively rich soils on young bearing palms after a dry spell following a wet period. It must be remembered that palms reaching the bearing stage are at a physiologically critical period, owing to the extra strain placed on the plant, and the increased call for nutriment, at this period, seems to place an extra strain on the plant, which becomes apparent when, for any reason, the conditions are not entirely favorable. It is a fact that certain types of palms are more liable to this "frond choke" condition than others, and usually they can be distinguished by their erect, close growth of narrow fronds, which appear to have a rather feathery appearance. In other words, there does appear to be an hereditary tendency for palms to show this undesirable type of growth.

In order to make certain whether or not the palms at this plantation were suffering because of natural soil conditions, soil samples were taken from a couple of widely-spaced areas where the palms were worst, and despatched to the Waite Institute, Australia, for analyses.†

The actual methods of planting at the particular sections of the plantation in question are not known, and probably planting was carried out roughly in the first instance. The source of the seed coco-nuts used was, undoubtedly, from local, unselected, native palms, and it is fairly safe to assume from the appearance of the palms and the nuts which they are bearing that no systematic seed selection of any kind was carried out. In this way, a large proportion of poorly vigorous palms can be perpetuated, which is often done because, in the first instance, the planter wishes to get his original seed nuts as cheaply as possible. Some individuals in this Territory have used germinated (or "krued") nuts without having the slightest idea from what kind of palms they were derived.

It must be mentioned, however, that some experienced planters here have referred to another cause of "frond choke" in palms. Its development has been noticed in rows where the natives, in the course of planting, had split the nut and detached the young plant—"krue"—from the nut, and eaten the kernel, and,

* Original report to owner by the author.

† The reports on soil samples from Kokopo by Mr. J. S. Hosking refer to these.

probably, the endosperm. They have even been known to dig up the nuts and eat this portion after they have been planted out, and then place them back in the same hole. The edible part is much prized by natives and it is likely that, at times, natives would eat this delicacy on new plantations unless they are closely watched. When there are no other groves in the vicinity they, of course, follow the easiest way to augment their rations. This is not common where proper supervision of the plantings is attended to.

It is believed, however, that the original seed coco-nuts were at fault in the affected areas, though it is very probable that the palms growing there will improve when they grow older.

As the owners are still planting up large areas, it would be preferable to obtain seed nuts from a bearing plantation which was known to be derived from selected nuts in the first instance, and, in this connexion, particular plantations in Kar Kar Island were mentioned by the owners as being suitable places from which to bring in seed nuts.

It is well known that Kar Kar nuts are noted for their size and weight, and there is a distinct possibility that they are the result of some original selection in the first instance.

It must be remembered, however, that the development of nuts on Kar Kar may be largely due to the environment. If it happens that the palms there represent a selected, or distinct, regional strain, that gives more chance of success. Some authorities, such as Sampson,[25] say that it is best to select good palms from areas where the soil approximates that where the palms are to be grown. Smith,[29] in Malaya, worked it out that it was best to select from the heaviest yielding areas which could be found, so that the chances were greatest of only good palms crossing amongst themselves. This is a complicated subject which is elucidated in an article on "Coco-nut Improvement by Seed Selection and Plant Breeding".[11] (See *New Guinea Agricultural Gazette*, Vol. 4, No. 3, p. 24.)

A common method of selecting seed nuts here is to select them from heaps gathered for copra cutting, and, in this instance, good, round, heavy nuts are usually, but not always, selected. This type of selection is definitely better than none at all, because the chances are high that good nuts would be obtained from good palms.

The great objection to the selecting of coco-nuts from a garnered heap is that one has no knowledge concerning the good points, or defects, or of the appearance and types of individual palms from which such seed coco-nuts were derived. A poor looking and weak palm may, in some instances, bear a very few good, shaped nuts, which would be selected from the heap and thus perpetuated.

A few of the most experienced planters in New Guinea have marked individual palms on old plantations and observed them singly for use as mother-palms for the production of seed nuts, as it is believed has also been done on some company plantations here. The idea, of course, is to select heavy bearing palms, and then to eliminate any uneconomic types. But all coco-nuts are the products of cross-fertilization, and, although the seed nuts are derived from good palms,

they do not necessarily breed true. The nuts from some palms are known to give a lower percentage germination than those from others, which is an hereditary tendency, and such palms should be avoided.

Selection in the nursery is not only desirable, but necessary, and only seedlings should be taken which are strong, sturdy and healthy. All inferior types and non-germinated nuts should be entirely discarded. It must be remembered that, as the seed nuts are the product of cross-fertilized flowers, regardless of the outside appearance of the nut, the seedlings derived from any one palm will display considerable variation. Long, rangy plants, or plants having a tendency to yellowing (chlorosis), should be avoided. Leggy, poor type seedlings can never produce good type palms, neither can those which are twisted or sickly.

It is also quite certain that, in addition to the above precautions, selective replantings in the field are a payable proposition, because it is not possible to separate out all the plants which are not likely to thrive from nursery selection alone. All plants which are not thriving and all misses in the planted areas should be replaced with strong, sturdy replants, and the best time for replanting is while the surrounding palms in the plantation are still young, and not too tall or well-developed, so that the replants receive little root competition, &c., and no excess shade. Any injuries to the young seedlings during replanting, or to the growing point by insects, rats, or animals in the young stages, provide a serious set-back to the plants for all time. Injured plants should be replaced as soon as they are noticed, and at as early a stage as possible.

The next important recommendation is that a substantial percentage over and above that just barely required to plant a certain area should be set out in the nursery. This, again, appears costly, but it is money well spent when it is remembered that the palms will be growing for over 50 years. Finally, if the owner-company has found that palms on any of their plantations are from nuts of good strain, well selected in the first instance, they are the ones recommended for use as a source of seed nuts. It is not now possible to say how coco-nuts from Kar Kar Island shifted to this Kokopo plantation will thrive, but probably they would be quite all right judging by experiences elsewhere.

All of the later plantings made by the owners, and these comprise the bulk of the planted areas, have been made with selected seed nuts under good, practical supervision. The difference between these well-planted palms and those seen on the earlier-planted areas is most strikingly in favour of the well-selected and properly-planted nuts.

The areas in question were recently visited—just twelve months after the report was made—and the improvement in the affected palms, especially those growing on one area, was clearly evident. There is still a proportion of the palms showing "frond choke" and "yellowing" plus a tendency to "leaf-droop".

The palms which have improved least of all are those which are in an area which was said to have been badly overgrown with "lalang" or "kunai" grass, *Imperata arundinacea,* in the early stages, and most of which has since disappeared. The fact that the ground, at this particular spot, is undulating,

and that closely-spaced, almost parallel tributaries running into a deeper stream are present, may increase the drainage and water run-off, and thus affect the palms growing on this light soil.

Reference should be made to the rainfall graph (page 45), where the rainfall for the year 1937 at the Kokopo plantation under investigation is compared with that of Namatanai, and a typical wilt area in Trinidad. It will be seen that this was a year of severely fluctuating rainfall, as, for example, compare the 19 inches recorded in March with the little 1 inch rainfall recorded in April, or the 3 inches in September with the 12 inches in November. One could expect physiological derangement of young bearing palms where a seven months' dry spell was experienced on the porous soils described, i.e., apart from the other contributory factors present.

Report on Soil Samples from New Guinea.*

(New Britain District.)

(By J. S. Hosking.)†

"Soil samples, representing two profiles from the coco-nut plantation in the Kokopo District, on the Island of New Britain, have been examined and the results are appended.

1. *Soils from Backward Area of Coco-nut Plantation, Sub-district of Kokopo.*

These soils have formed on geologically recent, layered deposits of volcanic ash, very similar to the deposits resulting from the recent volcanic eruptions at Rabaul and, like the Talasean soils, are extremely immature in their development. The deposits are of the pumiceous type, but show only a small proportion of pumiceous stone, about 3 per centum in the lower layers of the second profile.

The profiles consist of about 12 inches of a dark grey-brown to grey-brown clay loam to light clay, rich in organic matter overlying, in the case of (1) a light grey-brown clay loam to a depth of 42 inches, and in (2) a light grey-brown loam to 24 inches over a grey, passing to grey-white, pumiceous sand. Except for the sandy layer of the second profile, these soils have a distinctly silty feel and might well be classed as silty clays or silty loams.

Both profiles show reaction values which vary little from neutrality (pH 7) throughout their depth.

The surface soils are well supplied with plant foods, the nitrogen, phosphoric acid and potash contents showing average values of 0.4 per centum, 0.2 per centum and 0.3 per centum respectively. In the sub-soils, while the nitrogen content decreases rapidly, phosphoric acid and potash show only slightly diminished values.

Mechanical analyses and chemical data for these soils are given in Table I.

Water-holding capacity determinations indicate that under conditions which restrict or entirely prevent drainage the soils from Kokopo will absorb from 60 to 100 per centum of their own weight of water. The Kokopo soils are extremely porous, and the sandy nature of the sub-soil allows the water to drain away rapidly.

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* Abstract from a general report including other soil samples.

† Of the Division of Soils, Council for Scientific and Industrial Research, located at the Waite Institute, South Australia.

It is unlikely that the 'frond choke' conditions of the coco-nuts in this section of the plantation are the result of major plant deficiency, since all the soils examined are well supplied with plant nutrients.

A feature which is usually observed on light soils is the general wilting of the young, shallow-rooting coco-nut palms after long spells of dry weather, with, usually, subsequent recovery following heavy rains. During periods of drought, this type of soil will dry out rapidly, especially in the surface layers, and the shallow-rooting, young coco-nuts are, therefore, the more likely to be affected. Following heavy rains, the relatively high water-holding capacities allow the soils to regain the normal moisture status and restore the water balance of the palms."

Mr. Hosking's remarks on the comparison of the soils showing the described symptoms in coco-nut palms at Kokopo with soils growing palms similarly affected at Namatanai, New Ireland, are included earlier with a more detailed pathological description of the latter occurrence by the Economic Botanist.

TABLE 1.—MECHANICAL ANALYSES AND CHEMICAL DATA FOR TWO SOIL PROFILES FROM A SECTION OF AN EXTENSIVE COCO-NUT PLANTATION, KOKOPO DISTRICT, NEW BRITAIN, TERRITORY OF NEW GUINEA.

Site Number	1.			2.			
Sample Letter.	A.	B.	C.	A.	B.	C.	D.
Waite Institute Sample Number.	5382.	5383.	5384.	5385.	5386.	5387.	5388.
Depth in Inches.	0–12.	12–24.	24–36.	=0–12.	12–24.	24–36.	36–42.
	%	%	%	%	%	%	%
Pumiceous stone	..	..	..	..	..	3.4	2.4
Fine earth	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Coarse sand	4.1	8.2	15.4	7.1	19.6	31.9	33.6
Fine sand	22.4	26.9	31.2	26.3	38.4	45.4	43.0
Silt	30.1	33.0	26.4	29.3	25.0	16.2	14.3
Clay	28.9	21.2	22.3	22.7	11.0	4.8	5.8
Loss on acid treatment ..	4.1	2.9	1.4	3.7	1.8	1.1	0.4
Moisture	8.4	6.7	4.0	7.3	4.0	1.0	2.6
Loss on ignition	13.7	9.4	6.5	12.7	5.9	3.0	2.6
Phosphoric acid P_2O_5	0.21	0.10	0.03	0.21	0.15	..	0.13
Potash K_2O	0.26	0.27	0.14	0.35	0.34	..	0.28
Nitrogen N	0.42	0.20	0.08	0.36	0.08	0.03	0.01
Soil reaction pH	6.9	6.9	6.9	7.1	7.0	7.4	7.3

Other Records of Maturation Wilts in New Guinea.

Inquiries and personal observations lead one to the conclusion that there are few plantations in New Guinea where some areas of coco-nut palms do not display symptoms of nutritional disturbances, to a greater or lesser extent, when they are coming into bearing.

In Bougainville Island, near Kieta, the author saw palms at this stage which were similarly affected to those at Namatanai, except that the disease

was not so serious and the palms later recovered without any considered treatment on the part of the owner. In this case the areas affected were some 60 feet above the level of a small river and, as the ground was very free working, the water, apparently, got away easily. A good deal of pumice was mixed in with the soil. The fronds showed the same distinct spotting as was seen in the fronds from New Ireland and, also, a certain amount of tip-wither and leaf-break.

It was also seen that scale and mealy-bug insects were prevalent, especially one described by the Imperial Institute of Entomology for the Entomologist as a completely new genus, as yet unnamed. Also *Aspidiotus destructor* (red scale) and many colonies of *Aleurodicus destructor* were seen, together with a good deal of *Pestalozzia* spotting. The striking feature was the manner in which the various pests appeared to concentrate on the poorly vigorous palms. These palms were seen in the dry season, and later on, after heavy rains, were said to recover to a very large extent.

Since that time careful observations on several plantations, where palms were just coming into bearing, have shown that, in most places, patches are present in which the fronds show a typical yellowing or spotting, just as in the cases described. In some instances this is only apparent to a keen observer who is on the look out for the condition, and may pass unnoticed by the planter on the spot. This is mainly because, in such cases, the change in colour is not very great, and, secondly, because the symptoms disappear as soon as the climatic conditions improve and the stage of maximum nutrient requirements is passed.

In the same plantation it has been remarked, on numerous occasions, that palms on areas which have previously grown native foods or are planted over old native gardens present the worst appearance at the critical stages. It will be shown that there are sound chemical and physiological reasons for this being the case. Any retarding of the nutrient and water supply to the plant will have a quicker and more decided effect on palms growing on soils already exhausted, to a large extent, by previous cropping.

Observations have already shown (also recorded from other countries) that the effects of drought are greater on young palms than on adult palms.

Maturity of Coco-nut Palms in Malaya.

Dr. Jack[15] has made the following interesting comments concerning coco-nut palms coming into bearing:—

"Individual palms vary in the age at which they reach maturity, although field observations reveal no difference in growth.

On flat, alluvial land in this country (i.e. Malaya), it is commonly noticed that young palms, usually about ten years old, which have yielded well for two or three years, sustain a set-back and produce poorly for one to two years before again yielding good crops.

This habit is possibly an environmental effect resulting from a high water-table, which probably arrests the development of the natural root system temporarily, causing a shock which retards the growth for a time. The habit is, however, also recorded on estates which maintain a fairly low water-table (4 feet or more), so that it may be merely a growth character, marking the period after which the palms may be said to be mature."

It will be seen that this description fits several similar occurrences recorded in New Guinea.

Wilts at Maturation Period Compared with Wilting in the Mature Stages.

Were the disease in Namatanai to occur in the West Indies and elsewhere, it seems most probable that this type of disease which is herein tentatively referred to as "maturation wilt", would be classed in the same category as "bronze wilt" and as influenced by the same limiting factors. The disease at Namatanai seems, however, to be a more temporary derangement, and the necrotic spotting and streaking of the midribs appear to differentiate it.

It appears to us that this type of "die-back" is of a closely related type. It must be recognized that in a young palm just reaching the bearing stage there are several other contributory and interlocking, limiting factors acting which are not present in the same degree, once the palms have settled down to permanent bearing. The chemical composition, the relative amount of dry matter to moisture present, the root system and the economy of a young palm are quite different from that of an old, fully-bearing palm. As laid down for "Vernalization" procedure, it is necessary to distinguish between development and growth, and, as the plant develops from germination to maturity, it goes through several distinct stages. It stands to reason that the behaviour, or reaction, of the palm at one stage (in this case a critical stage in its life cycle, that of coming into bearing) to its environment is not the same as the reaction of an old palm to the same soil and climatic environment, e.g., the young palms are more susceptible to drought.

It will be seen from descriptions given later on, and references quoted,[4-2-8] that in the West Indies there is a tendency for coco-nut wilts to occur frequently in young palms, but one has seen no account of the disease appearing at such an early stage as was recorded at Namatanai.

The advisability of distinguishing "maturation wilt" from more permanent and serious "mature palm wilts", such as those described from New Guinea, in the latter portions of this article, must be considered.

In the next issue of this *Gazette*, the occurrences in New Guinea are compared with similar physiological diseases of coco-nuts recorded from other countries. The chemical and physiological changes which occur in coco-nut palms at various stages of growth are also discussed, in relation to the diseases described from New Guinea and elsewhere.

The importance of proper cultural conditions for the control of most coco-nut diseases, particularly those of physiological origin, is also stressed.

(*To be continued.*)

COWPEAS (*Vigna catiang*) AS A GREEN MANURE AND COVER CROP.

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

The value of cowpeas (*Vigna catiang*) as a green manure and cover crop is not fully realized by planters in this Territory, where a quick-growing plant is required to cover the soil, and so prevent the growth of weeds, grass, &c., and at the same time to provide a large bulk of nitrogenous material which is valuable as green manure.

The plant, which comes from India and China, is an annual bean-like plant and provides excellent pasture, good hay and ensilage, especially when grown in conjunction with other crops, such as maize, sorghum, or millet, but is best known for its value as a green manure.

In the southern States of the United States of America, cowpeas hold an important place in agriculture, because of the high yield of forage obtained and the seeds, which closely resemble field peas in composition, are fed to all classes of animals.

Henry and Morrison,[4] in the following table, give the composition of cowpeas seed as compared with corn, wheat, rice, barley and field peas.

	Digestible Crude Protein.	Digestible Carbohydrates.	Digestible Fat.	Total Digestible Nutrients.	Nutritive Ratio.
	Per cent.	Per cent.	Per cent.	Per cent.	1 :
Cowpeas	19.4	54.5	1.1	76.4	2.9
Corn	7.5	67.8	4.6	85.7	10.4
Wheat	9.2	67.5	1.5	80.1	7.7
Rice	4.7	64.6	1.7	73.1	14.6
Barley	9.0	66.8	1.6	79.4	7.8
Field peas	19.0	55.8	0.6	76.2	3.0

This shows cowpea seeds to be very high in their protein content, and to possess a very narrow nutritive ratio, so that when being fed to stock they would need to be fed in conjunction with a food rich in carbohydrates.

Like most crops, cowpeas do best in good soils, but they will grow on almost any soil providing the drainage is good. On poorer soils, their growth is superior to many crops and there is a tendency for the plant to produce less foliage, but a greater yield of seed pods. The best type of soil is that which is suited to maize and preparation of the seed bed is similar; in fact on the north coast of New South Wales these two crops are largely grown together when the maize is being grown for ensilage. In this case, the cowpeas are sown after the last cultivation of the maize crop, just prior to tasselling. In this way the nitrogen content of the soil is maintained and the quality of the ensilage is improved since it has a higher protein content than maize alone.

The seed should be sown in a fine, warm, moist seed bed and no difficulty will be experienced in establishing the crop. The plant will not stand cold weather at high levels but in coastal districts will stand up well to periods of dry weather. The seed may either be broadcast or sown in rows 3 feet apart and the seeds

6 to 9 inches apart in the rows. According to the variety (as the seeds vary in size according to the variety) ½ to 1 bushel of seed is required, if broadcast, and 10 to 15 lb. if in rows, to plant an acre. A bushel of cowpea seed contains 60 lb.

There are numerous varieties of cowpeas, the seeds of which are found in all plain colours and speckled or marked. The best and most popular varieties are Black, New Era, Victor and Whippoorwill.

Black is one of the oldest varieties and is probably grown more than any other. It is late maturing and produces a great bulk of green material. The vines are semi-procumbent in habit, and they bear large pods up to 9 inches in length containing large black seeds. These large pods, which ripen fairly evenly, are an advantage when harvesting the pods.

New Era is a much newer variety than Black and has the advantage of being resistant to wilt. It is much earlier in maturing than Black and produces almost an equal amount of green stuff. The pods are medium large and plentiful and are borne well up off the ground.

Victor is very resistant to wilt and resembles closely New Era except that it is a late maturer and at times a very shy bearer.

Whippoorwill bears medium large pods in great quantity. This variety has proved at Keravat Demonstration Plantation to be practically equal to Black in the bulk of green material produced and is well worth consideration.

Early varieties mature their pods in 70 to 90 days from planting and the crop may then be turned in or cut for hay, but the harvesting may be delayed much longer without appreciable loss.

Cowpeas are claimed in the United States of America to produce from 1 to 3 tons of hay per acre and are an excellent fodder for cattle, horses and sheep.

The following table[4] gives a comparison of the two legumes, lucerne and cowpeas, when fed as hay:—

—	Digestible Crude Protein.	Digestible Carbohydrates.	Digestible Fat.	Total Digestible Nutrients.	Nutritive Ratio.
	Per cent.	Per cent.			
Lucerne	10.6	39.0	0.9	51.6	3.9
Cowpeas	13.1	33.7	1.0	49.0	2.7

Where lucerne can be grown it is superior to cowpeas for hay and has the advantage of being more easily handled and cured. Cowpea hay is difficult to cure, but will withstand more rain than most hay crops during the curing period. In the southern States of America, cowpea hay is grown as a substitute for lucerne hay in areas of high rainfall, similar to the north coast of New South Wales.

When grazed cowpeas have a high feeding value and by first feeding off and then turning the crop under, much of the manurial ingredients is returned to the soil. Feeding off makes it easier to turn the crop under and decomposition takes place more rapidly.

Pigs like cowpeas and do well on them but it takes a little time for cows to become accustomed to them.

As a green manure crop, cowpeas are extensively grown in the sugar-cane districts of Queensland, and are also becoming more popular in a crop rotation with maize, this being practised on the north coast of New South Wales.

When a crop is turned in for green manure, decomposition takes place and humus is formed. This humus supplies plant food, improves the soil's texture, prevents too rapid evaporation of soil moisture and helps the soil to absorb and retain water. This decomposition also results in the formation of carbon dioxide which forms a weak acid (carbonic acid) in conjunction with water. This helps to break up the soil and to make available the plant food contained in it.

The following table[3] shows the amount of fertilizing ingredients added to the soil by ploughing under certain green crops:—

——	Average yield per Acre.	Percentage composition of whole plant.				Amount of fertilizing ingredients added to the soil in pounds per acre.		
		Water.	Nitrogen.	Phosphoric acid.	Potash.	Nitrogen.	Phosphoric acid.	Potash.
	Tons.							
Cowpeas ..	7½	84.4	0.63	0.13	0.46	106	22	77¼
Oats ..	8	75.0	0.72	0.19	0.56	129	34	100½
Rye ..	8	81.9	0.32	0.17	0.60	57½	30½	107½
Red clover ..	2	70.8	0.54	0.12	0.67	24	5½	30
White clover	2	80.0	0.43	0.12	0.40	19¼	5½	18
Lucerne ..	3	77.5	0.58	0.12	0.50	39	8	33½
Netchas ..	4–6	85.0	0.36	0.10	0.45	40	11¼	50⅓
Rape ..	2–4	85.7	0.35	0.12	0.62	23½	8	41½

On sandy soils green manuring helps to consolidate the soil by the formation of humus, which binds the particles together, whilst on clay soils this humus loosens the soil, and the carbon dioxide aerates it.

To derive full effects from green manuring sufficient warmth and moisture must be available to allow of rapid decomposition, and these two factors are usually to be found throughout the Territory for the greater part of the year. If the land is quite dry, decomposition will not take place and the effect of turning the crop in will be lost.

Many planters do not realize that to get full benefits from a cover crop, it must be periodically turned in to the soil and so more plant food is made available to the crop being grown. In the Solomon Islands, clovers are grown as a cover crop and it is the practice to plough them in every second year, and then allow them to re-establish themselves. This is best done by turning over between alternate rows of palms annually. Thus half the plantation is kept under a cover crop.

Many plantations in this Territory could be considerably improved if such a scheme could be carried out. Admittedly, ploughing is not practicable on many plantations, but good work can be done by regularly turning in cover crops with a hoe.

A quick-growing crop like cowpeas lends itself to the rapid improvement of soil and by establishing a small area and collecting the seed when ripe a large area can soon be established and regular turning in with hoes can be practised.

Most cover crops seen in this Territory appear to have been planted with the idea of controlling grasses and weeds only, and have been allowed to grow

unrestricted for years. No thought has been given to the idea of turning them in. This method certainly helps to maintain the nitrogen content of the soil and the decaying vegetable matter improves the soil. Much good plant food has been lost by not practising green manuring. The leaves and stems of all legumes as well as the roots, are rich in nitrogen, and, when it is realized that the removal of nitrogen amounts to 28.73 kg. per ton of copra,[1] it will be realized how necessary it is to maintain an adequate supply of nitrogen in the soil.

One might well quote verbatim the words of Dr. Bryce—[2]

It would appear that the system of cultivation on coco-nut plantations in the Territory, whereby the soil under the palms is allowed to remain under a permanent covering of grasses, does not provide the most favorable conditions for nitrification, though it may not be unfavorable to the fixation of nitrogen by free living bacteria. The cultivation of the soil by ploughing, harrowing, &c., would, therefore, stimulate nitrification and might depress nitrogen fixation by bacteria. The latter process, however, would probably be more than compensated for by growing a leguminous cover crop on the cultivated soil, and ploughing it in periodically, that is, by a system of green manuring.

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PIG RAISING NOTES.

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

Pigs will not make economical gains or remain in good health unless adequately fed, and it is important that the ration being fed is balanced. By this is meant the relationship of the protein content of the ration to the carbohydrate content, and this ratio differs according to the age and condition of the pig.

As an example, the nutritive ratio for fattening pigs is 1 : 5 to 1 : 5.5. This means that for every part of protein (nitrogenous substances) in the ration, there should be 5 or 5.5 parts of *carbohydrates* (starchy and fatty substances).

It has been proved that the feeding of an unbalanced ration may result in paralysis and unthriftiness in young pigs.

There are plenty of feeds available in the tropics for pig feeding, such as maize, kaffir corn, sweet potatoes, &c. These supply the carbohydrate portion of the ration which should be balanced by the addition of protein rich foods as milk, meat meal, peas, peanuts, &c. It seldom occurs that sufficient milk is available to feed to pigs, and this deficiency should be made up by supplying another food which is rich in protein. Meat meal is regarded as the best substitute in Australia, but freight costs may limit the use in the tropics. A ration showing economical returns in Australia consist of 5 lb. wheat or maize, ¼ lb. meal and 1 lb. green feed per day for a pig of 150 lb. live weight. This ration will give maximum gains in weight.

Pigs should be allowed as much grazing as possible and this will reduce the quantity of food to be fed. Any protein deficiency in the ration can also be made up by good leguminous pasture. Local *Desmodiums* and clovers, or cowpeas would be very good in this respect.

A plentiful supply of good clean drinking water is essential for pigs to make economical gains. Running water is good, provided there is no chance of any contamination from higher up the stream. Diseases are spread largely by this means.

Pigs should not be allowed access to stagnant puddle holes as these are also sources of infection, and it is in such places that the larvae of worms are to be found, from whence they infect the pigs.

Adequate housing should also be provided, with wooden floors, as pigs are very susceptible to dampness, chills and draughts, and once a young pig receives a setback it will never make economical gains and it is unwise to attempt to fatten it. It is best killed for home consumption, provided it has not become infected with any contagious disease.

FRANGIPANI.*

Its Beauty and Scent.

(By Walter W. Froggatt.)

All writers who have visited the tropics mention the delicate scented blooms of the frangipani (*Plumieria acutafolia*). It received its scientific name in honour of Charles Plumier, a French priest and botanist, who made three voyages into tropical America and the West Indies during the end of the 17th century. He died at Cadiz, Spain, while fitting out a fourth expedition in 1704. The frangipani was one of the many new plants which he introduced into Europe.

The genus *Plumieria* contains about 50 species of shrubs and small trees. These are confined to those parts of the world which extend from Peru to the West Indies.

The origin of its popular name "frangipani" is more involved. Some claim that it was named after Count Mercuteo Frangipani, an Italian traveller, who visited the West Indies in 1493. The sailors on the brig as they approached the shores of Antigua, noticed a fragrant scent; the Count pointed out the tree, and thus the plant received a name. The Count was a member of a very old Roman family, which received the title "Frangipani" from its benevolence in the distribution of broken bread (frangere, to break; panis, bread), during a great famine. Other botanists disclaim this Italian origin of the name. They give it a French origin and spell it "franchipanier", which means "coagulated milk", in reference to the quantity of thick white sap which pours out from any broken leaf or branch. It was well established along the shores of Southern Europe in the 16th century and was called a holy flower, because it was used in the decoration of the cathedral altars. It was not until 1790 that it was introduced into England, when Sir Joseph Banks presented some plants which he had obtained from the West Indies to the Royal Botanic Gardens at Kew, London. These plants flowered in the hothouses, and created great interest among the general public.

It is now a most popular plant in the tropical countries of the East. In India, it is used for decorative purposes in the Hindu temples. In the Malay Archipelago, the Malay name is "Banga Orang Sudah Mati", which means "dead men's fingers". The natives plant this shrub over the graves of their relatives, because of its beauty and scent when in flower. But its leafless branches resemble human fingers—hence the name.

The *Plumieria acutafolia* (frangipani) has clusters of great jasmine-shaped flowers. The petals are creamy white, and thick in substance, as if cut from kid leather. The bases of the petals are powdered with deep yellow; and the scent is as exquisite as the flower. The powerful, penetrating perfume known as "Frangipani" is made by perfumers with spices, orris root and musk, and is an imitation of the characteristic scent of the frangipani flower.

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* From *The Sydney Morning Herald*.

ESTATE PRACTICE EXAMINATION.*

19TH MARCH, 1938.

(Time allowed 4 hours.)

QUESTIONS AND ANSWERS.

FIELD WORK.

(Opening up New Jungle Areas.)

Questions 1 and 3 compulsory; one other question to be answered as well.

Question 1.

The I.R.R. Committee decided to permit companies to plant up a small percentage of their reserve jungle areas under the new scheme.

Your directors decided to take advantage of this opportunity, and you are instructed to select a suitable area of 100 acres for planting up on the latest methods.

You are told that you must have an original stand of approximately 200 plants per acre, and that the planting material is two basket plants per hole.

The land is hilly, but the ravines will not be difficult to drain.

Your directors request you to send them a rough sketch plan showing the salient features of the area as soon as you can.

Describe *briefly* your procedure from the time you received instructions to proceed with the work until the clearing is planted.

Answer 1.

Upon receipt of instructions to proceed with the selection and planting up of 100 acres of my reserve jungle land, my methods would be as stated below.

The land is hilly, and I would assume that only a light burn would be done, so that as much timber as possible would be left to help arrest erosion.

Details of work to be done—

1. Survey the area, cutting a 6-ft. rentis round the boundaries.

2. Cut 3-ft. inspection rentises every 10 chains across the area from east to west and north to south.

3. Take a field note book, and record as you walk along these rentises any salient features seen, such as swamps, steep ravines, lallang patches, outcrops of rock or laterite, &c., &c.

4. You can now draw your plan and with the aid of a local topo. survey map put in the contours approximately.

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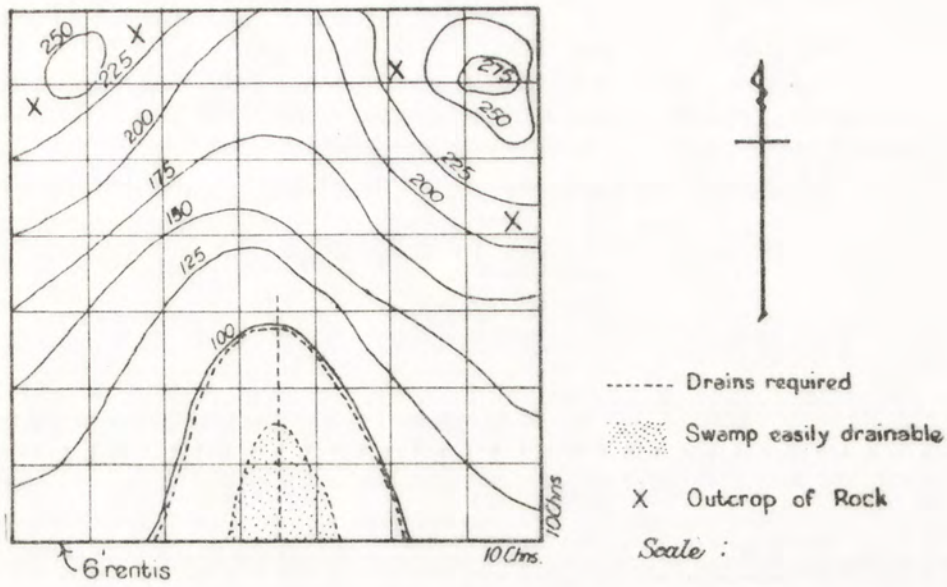
* From *The Planter*, April, 1938, Vol. XIX., No. 4, pages 166–175.

Your plan would then be something like this—



5. Now call in contractors and get tenders for felling, burning and clearing. It should be stipulated that wherever possible felling must be done on the contour.

A time and penalty clause should be inserted to ensure that the schedule is being kept up to date. The contract should stipulate that all trees to be felled should be cut off at 3 feet–6 feet from ground level. A fire-belt of 2 chains should be left round the boundaries where these are adjacent to forest reserve or old rubber; this is later felled and burnt off after the main burn is completed.

6. Whilst felling is in progress, a gang of Javanese drainers should be employed to cut the necessary drains before the trees are felled, and the felling contractor should be warned to see that his coolies do not close up these drains with felled timber.

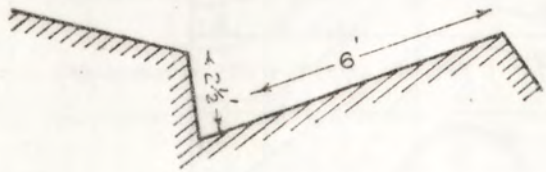
7. About three weeks after felling has been completed, when the weather is suitable, say no rain for four days, a light "scorch burn" should be put over the clearing.

8. Immediately after the burn is over a gang of lining coolies should mark out the planting lines on contour at a spacing of about 20 feet by 10 feet.

9. Coolies, sowing seed of a leguminous creeper or creepers, should follow the liners, and the seed should be established in drills between the planting lines. If sufficient money is available, then phosphate should be applied in the drills prior to planting, at the rate of 1 oz. per running yard. This helps the cover to get established quickly.

10. Chinese felling coolies will now follow the liners, clearing 6-ft. wide strips along the marked contour planting lines. All lying timber will be slewed round to form a bund, to help arrest erosion, and stumps up to 8 inches–10 inches will be eradicated along these lines.

11. Terracing will next be carried out. Terraces 6 feet wide, cut 2½ feet into the solid, will be cut and the spoil thrown forward and be well beaten to form a bund. Terraces should be cut on the wedge form, viz.:—



Stops of uncut earth 2 feet wide can be left between each plant or pair of plants along the contour. These stops help to arrest lateral movement of water along the terraces, and thus prevent large breakages occurring at any weak points.

12. Holes 2 feet by 2 feet by 18 inches will then be cut at each planting point, and these should be left open for some time, and then be filled with debris and good top-soil taken from between the terraces. It should not be necessary to apply fertilizers on this virgin land to begin with.

13. Regular rounds of weeding and lallang patrols will be carried out from the time the burn was completed.

14. Any extra drainage seen to be required can now be done.

15. Germination nurseries to receive good seed collected on the estate will now need to be prepared, with a top layer of fine river sand spread over the soil in the beds. Trenches should also be cut, and baskets filled with good earth be put upright in them to receive the seed after germination.

If the soil on the area is of a friable nature, then a small amount of clay should be placed at the bottom of the basket to save the earth falling out during transport to the field.

The nursery should have attap or palm shades placed over the beds, and these should be gradually removed to accustom the young plants to the strong sunlight. These nurseries should be scattered over the clearing to save transport charges later, and should be near water.

They should be fenced to guard against rats, and if snails are known to be causing trouble on the estate then Meta-Bran pellets should be placed round the nursery, outside the fence.

16. Due to the light burn, your natural covers should regenerate quickly, and these will probably need slashing back to 4 feet before planting takes place.

17. When the basket plants are about 14 days old, they can then be transferred to the planting holes in the field.

Care should be taken to cut the bottom of the baskets to allow the tap root to pass straight down to the bottom of the hole. A surplus of at least 10 per cent. of basket plants should be kept in the nurseries to allow for planting up failures.

In the event of rats causing losses, then rat baits, in which a poison is incorporated, should be put down over the area affected and, if necessary, wire guards should be made to enclose each pair of plants.

18. To stop sun scorch of the soil on the terraces, it has been found useful to plant seed or cuttings of *Desmodium ovalifolium* on them. This plant does not climb, and only needs to be kept back about 1 foot on each side of the rubber plants.

N.B.—If your directors insist on a normal burn, then this will be done three months after felling is completed, and the rest of the programme will remain the same as for an area lightly burnt off. Heavy burns arrest the regeneration of natural covers, and soil wash is often very serious. If, however, an estate is opening up an area adjacent to oil palms, it is often necessary to burn completely, to get rid of rats. The clearing should be fenced with a rat-proof fence if sufficient money is available, and if this is not possible a 4-strand barbed wire fence should be erected to keep out pig and deer.

Question 2.

When burning off a clearing, what precautions do you take to ensure that an even burn results and that no harm comes to the firing coolies?

Answer 2.

When burning off a clearing I should take the following precautions to see that an even burn ensued and that no harm came to the firing coolies:—

1. I should see that the timber was properly dry. For a normal burn the bark of the felled trees should be seen to be splitting.

2. I should wait for a period when I had good dry weather and start the burn after four days of completely dry conditions.

3. I should arrange to have sufficient coolies to have them spaced one coolie per chain across the area to be burnt off.

4. I should muster good coolies, count them and issue each coolie with a bamboo torch filled with kerosene, at the end of which would be placed a sacking wick. Each coolie would be supplied with a box of matches. I should explain carefully the procedure to be adopted, and see that the coolies realized they must keep a straight line, and not try and rush ahead of their neighbours. A Kangany should go with each 15 men.

5. At about 2 p.m. the coolies would be lined up on the far side of the area (towards which the wind was blowing) and be spaced at 1-chain intervals.

I would then station each Kangany in the middle of his party, and tell him that I would be on the left of the line, and that he must not start burning till he heard my whistle.

6. Coolies on hearing the whistle should start the fires and walk towards the wind, burning heaps as they go.

7. On completion of the burn, I should muster all the coolies and count them. I should then leave a few watchmen to see that smouldering logs did not start up new fires that might spread to the reserve jungle areas, or to the old rubber.

8. If my area to be burnt was adjacent to a forest reserve, then I would notify the District Forests Officer and ask him to have some forest guards stationed along his boundary.

Question 3.

You are advised that a series of consignments of expensive isolated garden seeds will be arriving at intervals during the next few weeks.

So that casualties amongst this valuable material may be kept as low as possible, describe how they should be dealt with upon receipt?

Answer 3.

Having been advised that a consignment of valuable isolated garden seed was due to arrive at regular intervals during the next few weeks, I would begin my preparation for their receipt *at once*.

1. I would order sufficient baskets for my requirements, and on their arrival would fill them with good soil and set them upright in trenches in a shaded nursery, or series of nurseries.

2. Germination beds would be prepared, and a top layer of fine sand would be spread over the soil. A fertilizer at the rate of 4 oz. per square yard would be incorporated in the soil.

3. The nurseries would be carefully shaded and well fenced, to keep out rats, &c. Baits for snails, if likely to prove troublesome, would be laid down on arrival of the seed.

4. If the nurseries were to be made in the replanted area, and were near old rubber, I should see that deep isolation trenches were cut, to stop the old rubber roots penetrating the nursery area and competing for the manure.

5. Upon arrival of the seed, which would be received by a competent person, the boxes would be unpacked and the seed established in the beds. The beds would then be lightly watered, and this watering would be continued twice daily whenever there was no rain.

6. The seeds after germination would be transferred to baskets, and these would be watered every day carefully.

7. Shading would be gradually removed to accustom the young plants to the strong sun.

8. Planting would then take place after about 14 days.

N.B.—If I were notified that germinated seed were being sent, then I should prepare baskets only, and plant direct from the boxes to them.

Question 4.

A clearing planted with seedlings to be budded later in the field is backward in growth at six months from planting.

Your agents require immediately as accurate a census as possible of plants likely to prove buddable at one year.

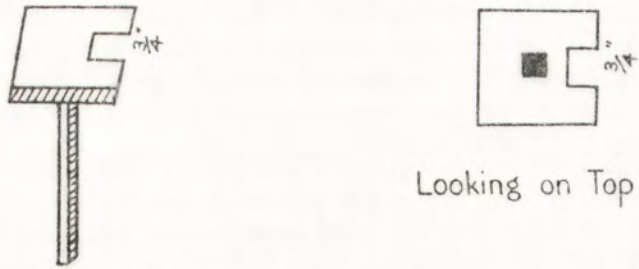
Describe your procedure.

Answer 4.

1. I should carry out a tree-to-tree inspection of all plants on this area.

Any plant found to be affected by root disease would be treated, but would not be included in the final census.

2. I would then have a series of small measuring sticks made, similar to the one shown in the sketch below—



These measuring sticks are more accurate than a tape, which when it gets wet tends to stretch. The reason I make the cut $\frac{3}{4}$ inch wide in the top of the measuring stick is because any tree that has a diameter of $\frac{3}{4}$ inch at six months will be found to be easily buddable by the end of a year. The leg is made 4 inches long, as this is considered by the R.R.I. to be optimum height from the ground for budding operations to be carried out.

The measuring sticks would be issued out to a Conductor and/or Kangany and they would be told to make a careful census, showing only those trees that either fit exactly into the nick, or are larger than it, as being likely to be fit for budding at the end of the year.

REPLANTING.

Question No. 1 compulsory: answer two other questions.

Question 1.

You are instructed by your agents to write to the directors of the R.R.I. and ask for the Institute's advice with regard to clones to be used on an area to be replanted.

What information is required by the R.R.I. from you in order that they may be able to select the clones most suitable for your particular situation?

Answer 1.

The R.R.I. in their *Journal* of October, 1937, Vol. 8, No. 1, page 74, state that they require the following information from estates when a request for advice on clones to be used during replanting is made:—

1. General brief description of the area; lie of the land, &c. Notes on the quality of the rubber trees cut out; age, growth, condition of foliage and bark, previous yields. Notes on history of previous cultivation.

2. Soil profile pits should be dug in representative parts of the area. Pits should be 6 feet deep by 3 feet square, and one side of the pit should be kept free of excavated soil.

3. Description of the soil profiles should be given on the following lines:—

(*a*) Position of pit, i.e., top, side or bottom of hill.

(*b*) Colour of soil with changes at different levels and the depths at which changes occur.

(*c*) Depth of organic colouring ("humus") of surface soil.
(*d*) Notes on texture and compactness of soil at different levels.
(*e*) Presence of stones, laterite (shape and size of lateritic masses is of interest), quartz fragments or other types of stones.
(*f*) Depth of water-table, if visible.

4. Average rainfall for the district should be given. The occurrence of heavy storms likely to result in damage to trees should also be noted, particularly if the area is in an exposed situation.

5. If young budded areas have been established on other parts of the estate on soil of similar type to that in the replanted area, notes on the appearance and vigour of different clones will be of great interest and value.

Question 2.

You are told by your visiting agent to put down ½ lb. of artificial fertilizer per hole during your replanting operations.

When would you apply the manure and in what position is it placed in the planting holes?

Answer 2.

Having been told by my visiting agent to put down ½ lb. of artificial fertilizer in the planting holes during replanting operations, I should incorporate this in the good soil that is placed in the top half of the planting hole, about 5 days before planting actually takes place. This point I consider especially important where replanting was being done on a friable soil.

If the manure is put at the bottom of the planting hole there will be a tendency for it to leech away before the rubber gets full benefit from it.

Question 3.

Why is it safer to use hand-pollinated and/or isolated garden seed when replanting, rather than to use so-called clonal seed collected from an area of mixed buddings?

Answer 3.

I should consider it safer to use hand-pollinated and/or isolated garden seed when replanting, rather than so-called clonal seed collected from an area of mixed buddings, for the following reasons:—

1. The hand-pollinated seed will have been made by artificial pollination from trees of proved quality, and the chances of variation amongst the resultant crosses will be considerably less than from seed collected from a mixed clonal area. Hand-pollinated seed is not usually available in commercial quantities.

2. Seeds from an isolation garden are also more desirable, as they, although they have crossed naturally, are presumed to be free from the risk of contamination from seedling pollen or pollen from a mixed area in which a number of poor yielders are situated.

3. If, however, I was satisfied, and the seller would guarantee that in his area of mixed clones he had a predominant stand of a strong mother tree such as Avros. 157, then I would not object to planting out this seed.

In the event of this guarantee not being available, I would prefer, as stated above, to use hand-pollinated or isolation garden seed.

Question 4.

Your clearing is hilly and has had to be terraced, and natural covers are trying to establish between terraces.

Signs of erosion, however, are to be seen, and your visiting agent recommends that low leguminous covers should be established and be allowed to climb over the natural covers, thus helping to arrest erosion.

Describe your method of procedure for establishing these low covers.

Answer 4.

My visiting agent having noticed that, despite the fact that natural covers are trying to establish between terraces, there are signs of erosion taking place, I would adopt the following precautionary measures:—

1. I would purchase seed of *Centrosema pubescens*, allowing for 8 lb. per acre.

2. In a small drill just below the terraces, I should apply a fertilizer, probably rock phosphate, at the rate of 1 oz. per running yard. The earth would be lightly scuffled over the fertilizer after it had been applied.

3. I would then plant my *Centrosema* seed at the rate of about 5 oz. per yard in this drill, and would take care to see that weeds, &c., were regularly eradicated and the young cover given a chance to establish and climb over the natural covers. Some people prefer to soak this seed overnight before planting; others consider that this is unnecessary.

GENERAL UPKEEP OF A PLANTED AREA.

Questions 1 and 2 compulsory: two other questions to be answered.

Question 1.

Your clearing has a healthy cover of *Pueraria, Calopogonium* and *Centrosema* established over it, and despite the fact that you are keeping 4-ft. diameter rings around the plants free of covers, you notice that the rubber is retarded.

Describe a method of cultivation that should help improve the growth, but does not necessitate fertilizers being applied.

Answer 1.

The retardation seen in the rubber is probably due to competition for moisture and plant food from the cover crops.

Three methods would appear to present themselves for consideration—

1. In the event of my agents instructing me to carry out the work as cheaply as possible then I should simply pull back the covers, leaving 6-ft.–8-ft. rings free round the plants.

2. If, however, the question of expense did not arise, I would prefer to cut and roll back the covers, leaving a 6-ft. ring free round the plants. The cut-off covers would then be buried in a trench cut between each pair of plants. This would have a beneficial effect on the rubber and would take the place of an artificial fertilizer.

3. Another method which is not as expensive as the one above is to pull the covers back so that 6-ft.–8-ft. rings are kept free round the plants. The rolled-back cover is then cut and spread over the exposed soil round the rubber plants. This helps to keep the soil cool and also keeps weeding costs down. A combination of methods 2 and 3 would be good.

Question 2.

On your clearing you have a stand of mixed bushy *leguminous* covers. These covers require slashing.

At what height do you recommend that these covers be slashed and during which periods of the year would you carry out slashing?

Answer 2.

I would slash my covers back to 4 feet during or just prior to the main wet seasons in March–April, October–December.

The cover will be flowering about this time and the nitrogen content in the leaves will be heavy. I would not slash my covers back during the dry season as the covers will not rot away quickly then, and there is also the danger of fire occurring. Further, the shade from the bushes is needed during the hot dry spells to keep the soil cool.

Question 3.

On your clearing, upon which the low leguminous creeping covers are establishing well and in which 4-ft. rings are kept free of covers round the plants, monthly weeding is done.

Describe the correct procedure to be carried out by your weeders in this area.

Answer 3.

My weeders on their monthly rounds would be given the following instructions:—

1. They would be told to eradicate all weeds seen in the rings or along the strips and in the covers between the rows.

2. They would be instructed to keep a careful look out for lallang and to eradicate this completely when seen. The eradicated lallang to be placed in "kutty sacks" and be brought back to the lines after work where it would be burnt off.

3. If hand-weeding is necessitated the weeders would be told to see that they knocked all the earth off the roots of the weeds as they pull them up and lay them on the cover outside the rings.

4. If Tajah weeding or forking is to be done weeders should weed the circles, one month towards the trees from the outer edge of the rings, and the next month away from the trees. This will prevent the formation of a hollow or a mound round the collars of the young plants.

Question 4.

Scale insects attack one of your nurseries, and you are instructed to get rid of these pests as quickly as possible.

Describe your method of procedure.

Answer 4.

Finding that scale bugs have attacked my nursery, I should issue the coolies with tins containing a soft soap-kerosene emulsion, or a tar-acid emulsion as is used for mouldy rot, and would instruct them to wipe the affected stems and branches of the plants in the nursery with a cloth dipped in one or other of these disinfectants.

Question 5.

On the area that you have to replant, the soil is of a friable nature.

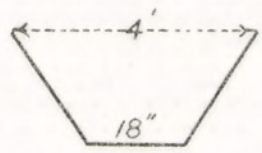
You are instructed to put in a drainage system prior to planting commencing.

What precautions would you take when cutting your drains to ensure that you did not experience considerable trouble in the future from slipping occurring on the banks of the drains?

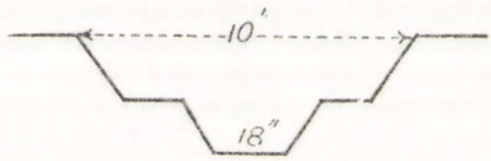
Answer 5.

Having been instructed to put in a drainage system prior to planting commencing in an area in which the soil is very friable, I would take the following precautions to ensure that trouble from bank slips was reduced to a minimum.

1. I would cut the drains, if small, with good sloping sides, say 4 feet at the top and 18 inches at the bottom, viz.:—



2. For the main outlet drains the sides would be cut with steps, viz.:—



3. The water in the bottom of the drain, especially during the wet weather, will tend to undercut the banks, and to prevent this I would establish a creeping grass such as *Axonopus compressus* from 6 inches above water level for 2 feet up the banks on either side.

I would not plant the grass right down to the water level, near coolie lines, &c., as this might make breeding places for *anopheline larvae* to collect. In some areas this undercutting of the banks after rains may necessitate revetting being done.

Question 6.

Your stand of young bud-grafts is 150 to the acre at four years of age.

Your agents instruct you to proceed with a thinning-out programme so that your stand will be reduced to 130 trees per acre.

Describe your method of procedure.

Answer 6.

It is generally accepted that within a clone bud-grafts can be thinned out on size and appearance.

Weak trees and those affected by root disease, white ants and wind damage will, therefore, be eradicated first.

In the event of this not being sufficient to bring the stand down to the required number, trees of small girth are next taken out.

It is not necessary to carry out test tapping unless the clones planted on your area are improved ones.

In the event of your having on your area a clone which is known to be a higher yielder than the others, it may be possible to keep a higher stand of this clone provided due attention is paid to spacing.

CONTROL OF PESTS AND DISEASES.

Answer two questions.

Question 1.

Describe the method of treatment recommended by the R.R.I. for the treatment of pink disease.

What precautions is it necessary to take to ensure that the disinfectant is correctly applied?

Answer 1.

The method of treatment recommended for pink disease by the R.R.I. is as follows:—

1. On trees with mature bark attacked by this disease the affected parts and also 6 inches of good bark (i.e. that in which latex can be seen to flow if scraped) above and below should be painted with asphaltum-kerosene mixture. This is made up by heating together 10 lb. of asphaltum D.X. and 1 gallon of kerosene or solar oil, and when cool adding one pint of a recommended wood preservative, such as Brunolinum, Noxo, &c.

2. On trees where the bark is still green it is better to paint with one of the water-miscible disinfectants that are used for mouldy rot, instead of the asphaltum-kerosene mixture (Killgerm Agrisol, Izal, &c.) at proportions recommended, i.e., 5 per cent.–10 per cent.

3. Dead or badly diseased branches should be painted first, and then be cut off and burnt. Painting can be done at any time, but it is best done when the trees are fairly dry. Cutting off of dead and badly diseased branches should be done in the dry weather and those affected parts should be burnt immediately.

4. It is important to remember that when using the asphaltum-kerosene mixture it must not be applied hot, and must be spread evenly over the whole affected part and not on one side of the branch only.

Question 2.

Describe briefly the treatment recommended by the R.R.I. for root disease control in young rubber.

Answer 2.

The method of control for root diseases in young rubber and the treatment employed as recommended by the R.R.I. of Malaya, is as follows:—

A careful tree-to-tree inspection of every plant in the clearing can be carried out quite inexpensively. The ground at the collar of each tree should be opened up to show about 6 inches of the lateral and tap roots.

Digging should be done with a pointed hard-wood stick, and changkols should *not* on any account be employed. The coolies should be instructed to try and keep root damage during opening to a minimum. The exposed parts of all the roots seen should then be examined for signs of root disease. If no rhizomorphs are found on the roots the holes should then be filled in and the soil trodden down firmly.

Where a plant is seen to be infected, the hole is left opened and treatment is later carried out as follows:—

1. Dig out until all infected roots are exposed. This will probably lead to the infected jungle root or old rubber root which has caused the infection.

2. Remove the source of the infection and burn it. If any other old rubber roots or stumps adjacent to the infected plants are seen they should be inspected and, if diseased, eradicated and burnt.

3. Cut off and burn all parts of the roots of the rubber tree which have been penetrated by the disease fungus.

4. Wash all other roots on which there are rhizomorphs, but which have not yet been penetrated (i.e. if they still contain latex), with a solution of 2 per cent. copper sulphate in water. While washing rub hard enough to remove the rhizomorphs, but do not rub too hard, for the copper sulphate will burn the bark of the roots.

5. Trees which are dead or seriously infected should be removed and burnt together with the diseased jungle or rubber roots which have caused the infection.

6. Trees which have been infected but have been treated should be marked with a paint band. If this is done it is easy to make a "kira" of the number of cases of infection and to plot out on a chart the infected areas.

7. Regular round of inspection should be carried out twice a year and again all infected trees should be marked. It is thus hoped that by the fourth or fifth year, the marked trees will show up the areas which are still potential danger spots and work can be concentrated on these areas to try and find the disease focus and remove it and opening up and inspection of healthy trees may prove unnecessary.

8. On replanted areas where there has been no history of disease in the past, and no disease was found when felling was carried out, an annual root disease inspection should suffice.

Question 3.

Root *Ustulina* is prevalent on your estate.

What precautions would you take to ensure that there was no recurrence of this disease on your trees?

Answer 3.

Finding that root *Ustulina* is prevalent on my estate I should institute a careful round of inspection and treatment.

Seriously affected trees would be eradicated and burnt, and those lightly affected would have the infected portion at the foot of the tree or on the root chiselled out until no more signs of the disease were to be seen. The cut surfaces would then be protected with a suitable wound dressing such as asphaltum-kerosene mixture or tar.

As the disease is carried by wind-blown spores I should see that all earth scrap latex round the base of the trees was carefully removed now and in the future and I would instruct the coolies to make as few wounds as possible whilst removing this earth scrap, any wounds made being treated immediately. These precautions should be sufficient to rid the estate of this trouble, as the spores can only gain entry to a tree through a wound surface.

FACTORY.

Answer any two questions.

Question 1.

Give the reason for copper contamination in sheet and how the danger of extraneous copper may be overcome.

Answer 1.

Danger from copper contamination in sheet can be overcome by eliminating all articles containing copper in the factory. Brass sieves should be scrapped, monel-metal ones should be purchased and be used. These monel-metal sieves and strainers are more expensive than the brass ones but last considerably longer and therefore repay the original outlay.

Copper contamination may also take place from worn bearings on the sheeting battery. When this occurs, the minute particles of copper reach the sheet along the rolls, on a thin film of oil. Care should, therefore, be taken to see that over-oiling is not done and that the rollers are cleaned regularly.

Question 2.

How do you proceed when receiving latex at the factory if you desire to obtain sheets standardized at 1½ lb. dry rubber content?

Answer 2.

To standardize latex to 1½ lb. D.R.C. the following method can be adopted.

Pour the latex on arrival at the factory through strainers into the Shanghai jars or bulking tanks. Then take a tin vessel and put into it one part of latex and two parts of water by volume; then take your metrolac and get the reading of the mixed latex and water. Multiply this reading by three which will give you the D.R.C. of the field latex.

Provided that the D.R.C. of your field latex is not less than 3 lb. per gallon fill your tanks half full of water and put the latex from the Shanghai jars or bulkers into your tanks. Stir well and take a second reading.

If the reading does not show 1½ lb. D.R.C. add more water and stir well and take more readings with the metrolac until the latex reaches the required standardization of 1½ lb.

In the event of the original reading of your field latex being less than 3 lb. D.R.C. the tanks should then only be quarter filled with water before the latex is added.

Formic acid is then added to the latex in the tanks at the rate of 7½ oz. per gallon of standardized latex. The latex in the tanks is then well stirred and all froth carefully skimmed off. The tank slats are then put in and the latex is left in the tanks overnight. Milling is done next morning.

Question 3.

Why is *para-nitrophenol* used in the manufacture of sheet rubber and how is it applied to latex in the raw state and for soaking purposes?

Answer 3.

Para-nitrophenol is used in the manufacture of sheet rubber to prevent the development of "mould and rust".

For adding to latex a stock solution is made by dissolving 1 lb. of the commercial solid in 10 gallons of water. One gallon of the stock solution is then added to 60 gallons of standardized latex before the coagulent is added. For soaking sheet a dilute solution of 5 gallons of stock solution is made with 50 gallons of water and the sheets are passed into this as they leave the marking machine. Fifty-five gallons of this solution are sufficient for 1,000 lb. of sheet per day. The solution should be renewed daily, and the stock solution should be prepared sometime before it is needed, as *para-nitrophenol* is not readily soluble in water.

Question 4.

Your smoke house is burnt down and you are told to erect immediately a temporary smoke house so that you may carry on until a permanent smoke house has been built.

State what type and capacity you assume the burnt-down smoke house to have been, and give approximate cost of the temporary building and its capacity.

Answer 4.

My smoke house, which deals with a crop of 2,800 lb. per day, gets burnt down, and I have to make preparations to continue smoking in temporary conditions. I would immediately call in a Chinese or Malay contractor and get him to put up eight temporary attap and bamboo smoke houses as recommended by the R.R.I.

These buildings, 12 feet square and 11 feet to the eaves, would consist of outer walls of split bamboo fixed on to hardwood posts. The inner walls and ceilings would then be lined with brown paper stuck on to the bamboo with sodium silicate or tapioca flour paste. Roofs of attap would cover the inclined ceilings. Ventilation holes 1 foot x 9 inches would be cut near ground on

three sides and two further ventilation holes would be cut in the ceilings. Two windows and a door would be made and be fixed. In each building a firebox from half (60 gallons) an old oil drum would be placed in the centre of each chamber with a corrugated iron baffle plate hung over it. Uprights with racks would be put in across the width of the building on both sides of the fireboxes. The uprights adjacent to the fireboxes would be enclosed with corrugated iron sheets to prevent them from catching fire. Chambers of these dimensions will hold 1,800 lb. of sheet rubber and provided the sheet is of a thickness of from $\frac{1}{8}$ inch to $\frac{1}{10}$ inch will dry the sheet in five days. Thus from each chamber one gets 350 lb. dry sheet per day making a total of 2,800 lb. from the eight smoke houses.

The cost of each of these buildings is at present approximately 70s. and therefore the total expenditure on the eight buildings will be 560s.

It is possible to get an insurance policy for European estates for sheet rubber smoked under these conditions.

Question 5.

Give reasons and remedies for the following defects in sheet:—

(i) Dark patches.
(ii) Greasy surface.
(iii) Pitted surface.

Answer 5.

Dark patches.—Irregularly shaped dark and light coloured patches often occur on sheets. These are caused by surface oxidation on the sheet, especially when coagulation is done in pans as the latex tends when coagulated to rise above the surface of the water.

Another cause is soaking sheets in water after rolling and allowing them to come into irregular contact with each other during this operation.

1. After coagulation the pans or tanks should be flooded with water to prevent the upper surfaces coming in contact with the air. The use of sodium sulphite in the latex will help to reduce this tendency to oxidation.

2. Sheets which are not spread with water during rolling and which are subsequently soaked in water should be placed singly in the soaking tanks in order that they may not become massed together.

3. When sheets are allowed to soak in water or have to be piled in a wet condition, they should be passed through a solution containing 1 lb. of *para-nitrophenol* in 100 gallons of water.

Greasy Surface.—1. Insufficient washing of the coagulum on the machine rolls. A water spray should be used on sheet machines.

2. The use of too strong a coagulant or too much sodium sulphite.

3. The use of firewood giving an excess of smoke products.

Moulds.—1. Soak the freshly-machined sheet in water if no water spray is available on the rolls.

2. Soak the freshly-machined sheet in a solution of 1 lb. *para-nitrophenol* in 100 gallons of water.

3. More efficient ventilation during the early stages of drying and smoking.

Pitted Surfaces.—Pitted surfaces usually take the form of small pockets or depressions on the surface of the sheet.

1. This is generally caused by careless skimming so that the surface bubbles remain, which are broken when the sheet is machined.

2. The division boards in the tanks may become sour owing to the growth of micro-organisms which set up fermentation when they come in contact with the slats.

3. A lack of water on the machine rolls so that the water only gets on the upper surface of the sheet leaving the lower roller dry. This may cause pitting of the surface of the sheet in contact with the lower roller.

Remedies are—

1. Proper skimming and removal of all froth.

2. Periodic skimming and washing of coagulation tank slats in a dilute solution of formalin and/or *para-nitrophenol* solution, and subsequent exposure of the slats to sunlight.

3. Solution of ½ lb. of *para-nitrophenol* to 10 gallons of water should be used for soaking boards and tanks.

4. More water on the rollers using an efficient spray so that both rollers get a fair proportion of water.

SANITATION AND ANTI-MALARIAL.

Answer both questions.

Question 1.

A wave of malaria among the labour force follows replanting of an area near the lines.

Describe—

(i) How would you ascertain whether the malaria does in fact emanate from the replanted area?

(ii) What precautions should have been taken at the time of replanting to obviate this danger?

(iii) What precautions must now be taken to render the areas safe?

Answer 1.

1. (*a*) I should take a muster of all coolies having fever or showing palpable spleens. I would try and trace out what these coolies had been doing for the past 10–12 days and see if the fever had been contracted on the estate or outside it.

(*b*) I would make the dresser do an anti-malarial survey of the replanted area and see if any anopheline larvae were to be found in planting holes, ravines or swamps. I should then state my conclusions to the V.M.O., and ask for his advice as to treatment to be adopted.

2. (*a*) All ravines, hollows and streams should have been carefully drained prior to falling being done, and care should have been taken to see that felled trees, &c., did not close up these drains.

(*b*) All planting holes likely to hold water should have been filled up as soon as possible.

(*c*) Regular oiling rounds over a mile radius should have been carried out.

3. (*a*) Labour force should be mustered and all coolies having fever or palpable spleens be put on treatment.

(*b*) Drainage as required to be put in hand at once and all holes holding water to be filled up.

(*c*) Regular oiling rounds instituted and close supervision be given to this work by the dresser.

(*d*) V.M.O. to be asked to inspect on his next visit and to approve methods used or to make suggestions for further improvements.

Question 2.

A coolie on your estate returns from the fields complaining that he has got fever.

What procedure do you adopt?

Answer 2.

1. Dresser should take two blood slides (one to be sent to V.M.O. for inspection).

2. Dresser to examine for spleen and take haemoglobin test.

3. If slide proves positive, put to bed and give 10 grains of aspirin. Ring up V.M.O. and ask for details of treatment to be carried out. If estate hospital available send to the hospital.

4. If no hospital available, and V.M.O. approves, give treatment on estate and, on completion of course, put coolie on an iron tonic course.

ECONOMIC DEVELOPMENT OF NEW GUINEA.*

An interesting paper by Dr. W. C. Klein, Secretary of the Netherlands New Guinea, published in the *Asiatic Review* (1937, 33, 566-580), compares the development of the resources and trade of Dutch New Guinea with that part of New Guinea which is controlled by Australia (Papua and the Mandated Territory). By means of statistics of exports he shows how in the exploitation of forest produce, such as gum copal, timber, rattans, nutmegs and mace, Dutch New Guinea is ahead of the Australian regions. This the author attributes partly to the skill of the Chinese trade in the former country in inducing the natives to bring certain of these products to the trading stations, whereas in Papua the traders are wholly, and in the Territory of New Guinea mainly, Europeans. As regards gum copal and nutmegs the trees are practically confined to the Dutch territory.

In the case of plantation products, on the other hand, there is a marked superiority in quantity and value on the Australian side. The most important of these is copra, which in the Mandated Territory and in Papua is produced mainly on European-managed plantations, whilst in the Dutch territory the bulk is native copra. The success of the industry in Australian New Guinea is considered to be due to a large extent to the more reliable labour supply, the better shipping facilities, and the proximity of the Australian market. The system of marketing is also better on the Australian side, being more in the hands of large firms.

Surprise is expressed that, in spite of the export bounty, the scientific work of the local Agricultural Department and the favorable soil conditions, the cocoa industry of the Territory of New Guinea does not make greater progress, especially in view of Australia's large imports of this commodity from West Africa and the West Indies. It is suggested that this may be due to the native kanakas being less intelligent than the Gold Coast natives, a fact which the author says accounts for the failure of the few cocoa experiments which have been made on the Dutch side.

Papua is the only territory of New Guinea which is exporting rubber.

Another product confined to the Australian side is desiccated coco-nut, which is now being made in both Papua and the Mandated Territory to supply the Australian market.

Metals also have hitherto only been produced in Australian territory, viz., copper in Papua and gold in both Papua and the Mandated Territory, especially the latter. A big prospecting campaign for gold has, however, been started in Dutch New Guinea.

A consideration of the value of the total volume of trade (exports and imports) shows that whereas in the Dutch territory the increase during the 30-year period commencing 1905 amounted to 70 per cent., in Papua it rose 300 per cent., whilst in the Mandated Territory the increase was no less than

* From *Bulletin of the Imperial Institute*, Vol. XXXV., No. 3 (July–September, 1937).

1,600 per cent. In the early days the exports from Dutch New Guinea exceeded the imports, whereas on the Australian side the reverse was the case. That is to say, the Dutch were taking out all they could from their territory, whilst in the remainder of the country money was being put in for its development. This sounder policy is now reaping its reward for the Australians, and it is only in the last few years that the Dutch have been spending increasing sums of money on development, largely in connexion with the exploration of gold already mentioned, and also in a search for oil.

SOILS.

Classification.—Soils are formed by the decomposition of mineral, animal and vegetable matter. They may be designated as sedentary or transported. Sedentary soils are those which remain near their source of formation, while transported soils have been carried by some geological agency from the place where they were first formed to some other. Soil as far as its composition and properties are concerned is extremely variable. The principal constituents of any soil, however, whatever its source, are nearly always silica, with varying amounts of alumina, oxides of iron, lime, magnesia, and the alkalies. A small amount of organic matter is also usually present. Soils are generally classified as gravel, sand, clay, loam, marl, peat and muck.

Gravel consists of small pieces of rock, worn smooth by abrasive action, mixed with sands and clays in varying proportions. Gravels occur throughout the United States and Canada in those districts which were at one time covered with the glacier. Gravel should contain enough binding material, mixed with the stone particles, to bind the whole into a solid mass. Clay is the most common form of binder found in gravel in its natural state. If present in too large quantities, however, it is detrimental. If gravel does not have sufficient binding material this can be remedied by adding some cementing material such as clay, shale, marl, loam, or stone screenings. Some gravels contain so much earthy material that it is necessary to screen them before they are suitable for road-making purposes. An indication of the binding qualities for pit gravel may be obtained by noticing the gravel in the pit. If the bank faces are vertical and the gravel breaks off into chunks, good binding qualities may be expected. River gravel generally contains less clay and more silica than the pit gravel of the same locality. Soil classified as hardpan may mean either a very compact clay, or a gravel which is cemented with clay or an iron oxide.

Sand is largely the result of breaking-down of sandstone rocks and a sandy soil so-called probably contains over 80 per cent. of pure sand. A sandy soil is hard to compact, and possesses little binding power unless wet or mixed with some cementing material such as clay. Quicksand is sand saturated with water, and possesses no stability.

Clay results from the decomposition of feldspar, oligoclase and micaceous rocks. A clayey soil might be termed such when containing at least 60 per cent. of clay. Clay when wet will swell and puddle with water, becoming very plastic. When mixed in the proper proportions with sand or gravel, it makes a very satisfactory road material in localities where stone is unobtainable. Clays used for fire clays in the manufacture of brick, besides being plastic, must possess certain refractory qualities which enable them to withstand long periods of heat at high temperatures without fusing. Shales are chemically the same composition as clays, but they have a laminated structure, and are similar in appearance to slates. Shales, however, will rapidly disintegrate on exposure to the atmosphere. In the south-western States a clay of which mud bricks might be made is called "adobe".

Loams may be any soil between sand and clay. They contain more or less of each of these two materials. They may be classified as heavy clay loams, clay loams, sandy loams, and light sandy loams, depending upon the quantity of the sand or clay content. In the Middle West a black loam which contains so much clay as to be sticky when wet is known as "gumbo".

Marl is a term which applies to all calcareous clays containing as a minimum 15 per cent. of carbonate of lime, and as a maximum 75 per cent. of clay.

Peat and *muck* are generally distinguished from other soils by the presence of humus or vegetable matter. They are formed by the decomposition of vegetable matter under water, and are undesirable materials for road-building.

HOUSEHOLD HINTS.

You can prevent olive oil from becoming rancid by dropping a lump of sugar in it. The sugar will not affect the taste of the oil.

* * * *

Salt is one of the most useful of household staples. Cracked eggs can be boiled without the insides oozing out by simply adding a teaspoonful of salt to the water. Sinks and drains can be kept free from grease and disagreeable odours by pouring a strong solution of salt and hot water through them once a week.

* * * *

To sharpen scissors, open them and gently draw the cutting edges back and forth on a piece of glass or the neck of a bottle as though you were going to cut it off.

* * * *

If soup is too salty, slice a raw potato and drop it in the soup. Bring the whole thing to a boil, then remove the potato and you will find that saltiness is gone.

* * * *

To keep your ice box sweet and fresh, put a small piece of charcoal in the back of it. The charcoal will absorb the various odours that accumulate in even the cleanest ice box.

* * * *

When it comes to cleaning knives—especially carving knives—an ordinary large size cork is better than a dish-rag. Put a little soap or scouring powder on the cork and rub it over the knife. To remove the odour of raw onions or garlic from knives, draw them through a raw potato.

* * * *

A bit of vinegar added to the water in which poached eggs are cooked will keep the whites of the eggs from spreading.

* * * *

To drive a nail into plaster without crumbling the plaster, dip the end of the nail first in melted wax or soap.

* * * *

If you have a vegetable or flower garden, don't throw away egg shells. Put them in a bucket, jar or other container, and fill the container with water. After it has stood for a day or so, the solution becomes an excellent fertilizer with which to sprinkle your garden.

* * * *

To iron over buttons, place the garment button-side down on the ironing board, and put some soft material such as a turkish towel beneath it. The buttons will leave their impression on the towel instead of on the garment you are ironing.

SHIP MEASUREMENT.

Under deck tonnage is a measure of the internal space between the top of the ceiling or double bottom in the hold and the under surface of the tonnage deck. The unit of measurement is a ton of 100 cubic feet.

Gross tonnage is a measure of the total internal volume of the ship, and is equal to the under deck tonnage plus the tonnage of all enclosed spaces above the tonnage deck.

Net tonnage is the residual tonnage after the various allowances for propelling power, crew, spaces and navigation spaces have been deducted from the gross tonnage.

Displacement tonnage is the total quantity of water displaced by the vessel when floating at her load draught.

Deadweight tonnage is the number of tons (of 2,240 lb.) of cargo, stores, &c., that a vessel is capable of carrying when floating at her load draught.

Load water-line is the water-line corresponding to the maximum draught to which a vessel is permitted to load, either by the freeboard regulations, the conditions of classification, or the conditions of service.

Draught is the distance from the lowest part of the keel to the water-line at which the vessel is floating.

Load draught is the distance from the lowest part of the keel to the load water-line as defined above.

Freeboard is the distance from the upper (or freeboard) deck to the centre of the disc which is marked on the vessel's sides and which indicates the position of the load water-line in summer.

TIME ON BOARD SHIP.

The day of 24 hours is divided into seven watches. The day commences at noon and is thus divided—

Noon to 4 p.m.	afternoon watch
4 p.m. to 6 p.m.	first dog watch
6 p.m. to 8 p.m.	last or second dog watch
8 p.m. to midnight	first watch
Midnight to 4 a.m.	middle watch
4 a.m. to 8 a.m.	morning watch
8 a.m. to noon	forenoon watch

The purpose of the two dog watches is to make an odd number of watches in the 24 hours, thus giving the men different watches each day.

Time is kept on board ship by striking a bell every half hour, the rule being—One stroke of the bell at half-past four, half-past eight, and half-past twelve, one more stroke being added for each half-hour until eight strokes of the bell or eight bells are reached at four, eight and twelve. The dog watches are different, 6.30 p.m. being one bell, 7 p.m. two bells, and 7.30 p.m. three bells, but 8 o'clock is always eight bells.

MENSURATION OF SURFACES AND SOLIDS.

The circumference of a circle = diameter × 22/7 (or 3.1416); area of circle = square of the diameter × 0.7854.

Area of sector of circle = length of arc × ½ radius.

Area of segment of circle = area of sector less area of triangle.

Area of a square, rhombus or rhomboid = base × height.

Area of a triangle = ½ base × perpendicular height.

Area of equilateral triangle = square of side × 0.433.

Area of any right-lined figure of four or more unequal sides is found by dividing it into triangles, finding area of each and adding together.

Area of a parabola = base × height × ⅔.

Area of an ellipse = long axis × short axis × 0.7854.

Volume of a pyramid = area of base × one-third of height.

Volume of a sphere = cube of diameter × 0.5236.

RAINFALL.

The depth of rainfall in inches, multiplied by 3,630, equals number of cubic feet per square acre; multiplied by 22,688, equals number of gallons per square acre.

Thus—

Inches.		Cubic feet per acre.		Gallons per acre.		Tons per acre.
1	=	3,630	=	22,688	=	101.3
2	=	7,260	=	45,376	=	202.6
3	=	10,890	=	68,064	=	303.9
5	=	18,150	=	113,440	=	506.5

1 cubic foot of water = 6¼ gallons = 62½ lb. = 1,000 oz. = about ¾ bushel. 40 × 10 × 10 feet (4,000 cubic feet) = 25,000 gallons. 1 cubic inch of water = ⅗ oz. by weight. 1 pint of water = 20 oz. by weight. 1 gallon of water = 10 lb. by weight. 1 ton of water = 224 gallons. 1 oz. of water = 1 oz. by weight. 1 lb. of water measures 27¾ cubic inches. 1 ordinary tumbler holds 10 liquid ounces. 1 tablespoon holds ½ liquid ounce. 1 teaspoon holds 1 liquid drachm or 60 drops. 4 teaspoonsful = 1 liquid ounce.

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