THE

New Guinea Agricultural Gazette.

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EDITORIAL NOTES.

Recently approval was given for the appointment of the Agricultural Chemist as Editor of the *New Guinea Agricultural Gazette*. In future, it is proposed to issue four *Gazettes* a year in the following months—February, May, August and November. Those desirous of submitting material for publication should arrange that it reaches the Editor ten weeks before the first day of the month of publication of the *Gazette* for which it is intended.

The main features of this issue are the annual reports of the senior officers of the Agricultural Department and two articles by the Assistant Entomologist on coco-nut leaf pests.

Recently, *Promecotheca papuana*, Csiki, was discovered on a plantation on New Ireland. Fortunately, only a few palms were affected. These were cut down and burnt, and a careful lookout kept for other affected palms. This is the first record of the disease occurring in New Ireland.

Many inquiries have been received of late as to the prospects of rubber production in the Territory. As a result, the Economic Botanist is preparing a detailed report which, it is hoped, will be ready for publication in the next *Gazette*.

Cacao is another crop which is receiving added attention of late. Owing to war conditions restricting the importation of cacao from other countries, the New Guinea product is now bringing a much better price in Australia. This crop does well in many parts of the Territory and commences to bring in returns after about three years. Seeds of high quality may be obtained from the Keravat Demonstration Plantation at a reasonable price.

ANNUAL REPORTS OF THE DEPARTMENT OF AGRICULTURE FOR THE YEAR ENDING 30TH JUNE, 1939.

DIRECTOR'S REPORT.

The Director, apart from administrative duties, paid many visits to plantations in the Gazelle Peninsula and directed operations at the Demonstration Plantation, Keravat. He also made an extensive tour of inspection of plantations on New Ireland from Kavieng to Namatanai, with Mr. G. W. Stanley, Inspector and Instructor, during which land for the head-quarters of an inspector and instructor was selected at Bo, Namatanai district. The locality chosen is on a branch road of the East Coast-road, New Ireland, so that, with a vehicle, the inspector can be in frequent touch with most planters and natives on New Ireland, the largest coco-nut growing area in the Territory. The Director addressed a meeting of planters at Kavieng on copra production which was well attended.

A visit was paid to Aiyura, 6,000 feet elevation, for the purpose of inspecting cinchona, coffee and other crops introduced to that highland district. Too much cannot be said for the energy and enterprise shown by the Officer-in-charge of that station, and the commanding influence he and his wife have over natives from the so-called uncontrolled area.

Later, the Director visited Wau, 3,000 feet, where he inspected several farms which the owners were struggling to establish by the production of food crops for the European settlement. The coffee, *Arabica* (Blue Mountain Jamaica), introduced by the Department eight years ago is still thriving and producing heavy crops which shows the district to be well suited for this valuable crop.

At Lae the holdings of the settlers in that district were inspected and instructions given to the owners individually, in addition to a public address on cacao and rubber planting. The meeting was attended by practically all the residents of Lae and apparently was greatly appreciated.

Mr. J. L. Froggatt, Entomologist, was largely engaged during the year on the breeding and distribution of parasites, particularly *Pleurotropis parvulus*, of the coco-nut leaf mining pest *Promecotheca papuana*, full particulars of which are given in a separate report.

Mr. R. E. P. Dwyer, Economic Botanist, made an extensive patrol of the north-western islands to investigate the decreased production of coco-nuts in that portion of the Territory.

An Agricultural Chemist was appointed to the department and when he commences duty, reliable advice on chemical fertilizers can be supplied to the planters.

Mr. B. A. O'Connor, stationed at the Entomological Field Laboratory at Manus, was engaged on investigations for the control of the coco-nut tree-hopper, *Sexava*, and proved that dusting with arsenical powders could effectively control the pest. He was also employed in breeding and liberating *Pleurotropis parvulus*, on Lindenhafen and other areas infested with *Promecotheca papuana*.

Mr. C. C. Marr, Inspector and Instructor, has been stationed at Vunakanau in charge of native agriculture and to advise planters in the Kokopo district. The natives in this district being between two centres like Rabaul and Kokopo, are probably the most sophisticated in the Territory, but Mr. Marr's experience of native mentality has given him considerable influence over them.

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TERRITORY OF NEW GUINEA.

DEPARTMENT OF AGRICULTURE.

Director	The Hon. G. H. Murray, F.R.E.S.
Entomologist	John L. Froggatt, B.Sc.
Economic Botanist	R. E. P. Dwyer, B.Sc.Agr.
Agricultural Chemist	R. C. Hutchinson, B.Sc.
Superintendent, Keravat Demonstration Plantation	E. C. D. Green.
Inspectors and Instructors	F. O. Moody. M. C. Crocker. C. C. Marr. R. F. Brechin. F. C. Henderson, B.Sc.Agr. I. J. L. Wood. G. F. Gee. J. A. Ewen.
Clerk	B. G. Challis.
Assistant, Botanic Gardens	C. F. R. Gilbert.
Assistant, Keravat Demonstration Plantation	L. T. Hurrell (War Leave).
Typist	Miss E. I. G. Chopin.
Supernumeraries:—	
Assistant Entomologist	B. A. O'Connor, B.A., B.Sc.Agr.
Inspectors and Instructors	W. A. Mossman. G. E. Guthrie. G. W. Stanley. E. Caulfield-Kelly.
Assistant Clerks	Chee Hoi Meen. Lee Chun Loy.
Head Gardener, Botanic Gardens	Ah Fat.
Head Gardener's Assistant	Bick Hing.
Storeman	Lam Tom Hung.
Carpenter	Ah Tong.
Asiatic Assistants, Keravat Demonstration Plantation	Mally Ah Mat. Hans Luker.

Editor of the *New Guinea Agricultural Gazette*	R. C. Hutchinson, B.Sc.

Mr. Brechin, Officer-in-charge of the Agricultural Station at Aiyura, on the Upper Ramu, Mainland of New Guinea, is doing good work amongst totally uncivilized natives. Soy beans and other new foods have been introduced to them and the improved dietary should have a beneficial effect on their stamina. Natives come from long distances within the uncontrolled area and make friendly visits to the station, getting instruction in agriculture and taking seeds and plants back to their village gardens. Cinchona of four types, including high quality *C. ledgeriana*, are thriving at the station and there is good reason to believe that it may yet be the foundation of a new industry. Arabian coffee, tea, pyrethrum and many fruits are established on the station.

Pests and Diseases.

The two most serious coco-nut pests in the Territory have received careful study by the entomological staff and very satisfactory progress has been made. The parasite, *Pleurotropis parvulus*, has, we have good reason to believe, become established in the Territory and has brought the coco-nut leaf-miner beetle, *Promecotheca papuana*, under control. The parasite, *Leefmansia bicolor*, has not proved as successful as hoped on Manus, but demonstrations prove that the pest can be kept under control by dusting with arsenical powder.

Attempts are being made to introduce *Tetrastichodes*, parasites on the leaf hispa, *Brontispa froggatti*.

The *Bufo marinus*, introduced from French Guiana, via Trinidad, Hawaii and Queensland, has become thoroughly established and reports indicate that it is successful in controlling various insect pests including *Hippotion celerio*, a serious pest of sweet potatoes. Many other insect pests and diseases have been investigated by the entomological staff and the Economic Botanist.

Copra.

The year 1938-1939 has been an unfortunate one for the coco-nut planter on account of the depressed state of the copra market. The drop in prices started in February, 1938, and there was a slow and steady decline so that only those planters producing under the most favorable circumstances were able to have a margin of profit. Nevertheless, there is no reason for undue despondency, as copra produces the most valuable of all vegetable oils but, like the wheat farmer, the coco-nut planter must endeavour to increase his yields per acre at the lowest possible costs if he is to obtain reasonable profits. The correct use of leguminous cover crops, tall as well as creeper, and the right application of suitable fertilizers, have been repeatedly used to increase yields unless the plantation is too far gone.

Desiccated Coco-nut.

The production of this commodity has been maintained and sells at remunerative prices in Australia. There is no possibility of expanding this branch of the industry as Australian demands can be met with the present production and, as an export trade, there is not much likelihood of being able to compete with Ceylon.

Fresh Coco-nuts for the Fruit Trade.

This small industry apparently has collapsed as it suffered from infrequent shipping facilities and could hardly be expected to be able to compete with nearer coco-nut growing countries like Fiji.

Coir Fibre.

There is one mill established in the Territory and the samples of fibre examined by the Department were quite equal, if not superior, to the Ceylon article.

Coffee (Robusta type).

In one instance, this industry suffered from bad plantation management, but another large plantation has been put under a capable manager and reports show that there has been a great improvement in its maintenance and yield. Arabian coffee at Wau, 3,500 feet above sea level, still continues to yield heavily and the owner has extended his planted area. The small area of this variety (Blue Mountain Jamaica) at Aiyura is very healthy and has commenced bearing.

Cocoa.

The area planted with this crop continues to increase but, despite recommendations of the Department of Agriculture, few planters take the trouble to plant selected seed, although seed of high quality trees at Keravat are available at reasonable rates.

Tea.

The plants introduced to the Agricultural Station, Aiyura, suffered a serious set-back and a number were destroyed by fire, but those remaining are now coming on well.

Derris.

Little advance has been made in the cultivation of this valuable crop. It is a relatively quick-growing crop compared with coco-nuts but many planters in this Territory, accustomed as they have been to the latter, find difficulty in entering upon a new crop that requires cultivation in its early stages.

Rubber.

On account of the higher prices now obtained from this product and the depressed state of the copra market, several planters are talking of entering upon its cultivation. Numbers of planters have purchased seed of *Hevea*, but no new plantations have yet been started.

Cinchona.

Four species and hybrids, including *C. ledgeriana*, of this plant have been established at the mountain agricultural station, Aiyura. The growth of these plants has been very satisfactory and, considering their age, seems to indicate that soil and climate are even suitable for the more delicate and valuable *C. ledgeriana*.

Peanuts.

This plant has now entered into native agriculture, being always found in every village garden, and is much appreciated in native diet.

Vegetables.

An increasing quantity of European vegetables is now being grown by natives in the neighbourhood of settlements for which there is a good demand from Europeans and Chinese. Seeds were introduced by the Agricultural Department in the first place, but the product is far inferior to cold storage vegetables imported from Australia. Inspectors and instructors of the Department are doing their best to raise the standard of these crops by instruction to natives.

Assistance to Planters.

Every possible assistance continues to be rendered to planters. Parasites for the control of *Promecotheca*, a serious pest of coco-nuts, has been bred in the Department's entomological laboratory and distributed to planters in all those districts attacked by this pest.

Advice has been given on many subjects to planters by the Director and other members of the staff, and several planters have expressed their appreciation of the assistance thus rendered.

Selected seeds of high-yielding cacao, coco-nut and other plants have been distributed in large quantities at reasonable prices from the Demonstration Plantation. Small numbers of plants of economic and ornamental types have been distributed gratis for experimental purposes from the Botanic Gardens.

Samples of soil have been continued to be sent to the Waite Institute in Australia for analyses. This is very kindly done as a special favour to the Department, as we have no claim on the services of this institution.

Native Agriculture.

This branch of the Department's activities has received every attention throughout the year, as it is an important part of the duties of inspectors and instructors.

Three inspectors have been stationed in centres of relatively large native population and have been able to be in frequent contact with the natives to advise and instruct them in improved methods of cultivation, and introduce new food plants to them. In certain cases, even tools have been issued to them on loan.

Practically all native coco-nut groves throughout the Territory have been inspected, and in many cases there has been a marked improvement in their maintenance by the introduction of cover plants and correct cultural practice.

Owing to the slump in market prices, natives have shown a distinct disinclination to turn their nuts into copra, which, after all, clearly shows that copra production is not essential for their maintenance. Their gardens are sufficient to provide them with all their food requirements and copra is only used to provide them with the luxuries of life. Until these luxuries become essentials, thus raising the standard of living, we can hardly hope for any permanency in advanced native agriculture.

ENTOMOLOGIST'S REPORT.

From January, 1939, to June, 1939, the Entomologist was appointed Acting Director during the absence of the Director on sick leave.

Owing to the very close attention required in the *Promecotheca* parasite breeding and the extra duties entailed as Acting Director, the Entomologist has not been able to visit other portions of the Territory for the greater part of the year.

The following areas, however, were visited:—

Manus and the Western Islands—from 19th July to 30th July, 1938.

Buka Passage sector—from 13th to 24th August, 1938.

South Coast, New Britain—from 5th to 13th September, 1938.

Pondo Plantation, New Britain—23rd to 29th September, 1938, and 12th to 16th May, 1939.

Rabaul-Kokopo area visited on single-day trips in connexion with observations on various pests.

Parasites of *Promecotheca papuana*, Csiki: On 6th October, 1938, a colony of *Pleurotropis parvulus* larval and pupal parasites of *P. papuana* was landed successfully by air liner from Fiji through the assistance and co-operation of W. R. Carpenter & Co. Ltd.

Two previous unsuccessful attempts had been made to introduce this parasite, one from New Hebrides and one from Fiji.

Breeding of *P. parvulus* to build up stocks of the parasite for liberation was immediately commenced; the life-history of this species, together with that of the two indigenous larval parasites *Eurytoma promecothecae*, Ferr. and *Closterocerus splendens*, Kow. was studied in detail, and in each case the life was found to be approximately half that of the host. Instruction in breeding these parasites was given to several planters who desired to build up the parasite population on their own plantations.

Breeding material was drawn mainly from one plantation in the Kokopo district, where a mild infestation of *P. papuana* was present over a large area of young coco-nuts; a few other localized centres of mild infestation in the Rabaul-Kokopo area also contributed a quota. Early in December, 1938, the supply of material available showed a marked decrease and declined steadily until the end of January, 1939, when it had practically ceased. This was due to the combined effects of the three species of parasites referred to.

Liberation of *P. parvulus* was commenced early in November, 1938, in the Rabaul-Kokopo area wherever any evidence of infestation by *P. papuana* was observed. Colonies were also despatched from Rabaul to the Talasea sub-district, New Britain, and to Manus District.

Owing to the limited supply of breeding material from the inception of the work in Rabaul, and the continued prevalence of the pest in the Gasmata sub-district, New Britain, the Assistant Entomologist was, in November, transferred from Manus district to Gasmata sub-district, with head-quarters at Lindenhafen, to carry out breeding and distribution of *P. parvulus* and to make a general study of the pest and any indigenous parasites in the latter area.

From this area liberations of *P. parvulus* were commenced early in December, and were recovered from parasitized larvae collected in the field early in February. The single phase of *P. papuana* has persisted in Lindenhafen, and it has been found that this condition has, to date, militated against a mass carry-over of the parasite from one host generation to the next. This matter is receiving further study.

Colonies were also supplied from the Field Laboratory, Lindenhafen, to other centres in the Gasmata sub-district, for Linga-Linga, Talasea and for Manus.

A ready control of the adult beetles has been obtained by spraying with Arsenate of Lead and Nicotine.

Rhyncophorus papuanus, Kirsch (Black Palm Weevil), has given a considerable amount of trouble in the Gazelle Peninsula, New Britain. Tests are being started with a proprietary preparation from Ceylon.

Two consignments of copra from a plantation in the Manus group were so heavily infested with the larvae of *Ephestia cautella* that fumigation had to be resorted to in order to prevent increased population of the moths in the sheds. The bags were stacked in the Departmental fumigator in rows with dunnage between layers and treated with hydrocyanic acid gas for 48 hours, the fumigant being generated from "Cyanogas" calcium cyanide used at the rate of 3 lb. per 1,000 cubic feet.

The Braconid, *Bracon bebetor*, Say, was later found breeding in considerable numbers in the *Ephestica* larvae.

The Giant Toad, *Bufo marinus*, is being distributed to various parts of the Territory to endeavour to control the pest, *Hippotion celerio*, of sweet potatoes.

At the break of the dry season at Buka Passage, cutworms did considerable damage to various crops for a short period until parasites gained control. *Prodenia litura* on Taro, *Heliothis obsolela* on Maize were particularly numerous and *Pseudococcus* sp. and *Coccus viridis* on coffee. Spraying with a miscible oil spray has given control of these coccid pests.

The following articles were published during the year in the *New Guinea Agricultural Gazette*:—

(1) "Measures for Control of *Sexava* spp."
(2) "Weevil Pests of Cocoa."
(3) "Pests of Cocoa in the Territory of New Guinea."
(4) "The Coco-nut Leafminer, *Promecotheca papuana*, Csiki, and its parasites in the Territory of New Guinea."
(5) "Fumigation and Fumigants."
(6) "Insect Pests of Rice."
(7) "Copra Infestation by *Ephestia cautella* and fumigation for its Control." (With Mr. F. O. Moody as co-author.)

The following insect pests, parasites and predators are recorded for the year, and were either bred or collected in Rabaul and other parts of the Territory:—

Coco-nuts—

Coccidae—*Dinaspis reitchii*, Green and Laing.
Coccus mangiferae, Green.
Ischnaspis longirostris, Sign.
Pinnaspis pseudoaspidistrae, Green.

Parasites of *Promecotheca papuana*—

Eulophidae, *Eurytoma promecotheca*, Ferr.
Closterocerus splendens, Kow.
Derostenus sp.
(all larval parasites).

Eupelmidae, *Anastatus* sp. (egg parasites).
C. splendens and *Anastatus* sp. are recorded from Manus and New Britain.

Predator of *Promecotheca papuana* adults—
Pentatomidae, Anyotea reciprocus, Wlk. var.
Sexava egg parasites, Lilui Island—
Scelionidae, Prospagus attrellus, Dodd.
Eulophidae, Tetrastichodes sp.

COPRA—
Pyralidae, Ephestia cautella, Wlk.
Bracon hebetor, Say, (Braconidae), larval parasite of *E. cautella*.

COCO-NUT SPATHES—
Curculionidae, Meredolis cocotis, Mshll. (collected Kokopo, New Britain).
Metroxlyn sagu—
Curculionidae, Rhyncophorus kaupi, Schauf. (collected Huon Gulf, Morobe District).

COCOA—
Noctuidae, Erias citrina, Saalm. on foliage.
Eucosmidae, Laspeyresia sp.—larvae boring in shell of pods.
Limacodidae, Scopelode sp., on foliage.
Coccidae, Pseudococcus sp. on pods.
Thysanoptera—Heliothripis haemorrhoidalis, Bouche, *Selenothripis rubrocintus*, Giard, both spp. on the foliage.

ERYTHRINA—
Noctuidae—Othreis fullonica L. on foliage; the adults of this moth caused marked damage to ripening citrus, pawpaws, bananas, &c.
Coccidae—Ferrisia virgata, Ckll.

COFFEE—
Coccidae: Coccus viridis Green.
Mealybug predators—
Coccinellidae, Alesia lineata, Thumb.
Cryptolaemus montrouzeri, Muls.
Scymus sp.

LYGAEIDAE—
Scopiastes sp.—this specimen was always present in numbers on coffee bushes infested with mealybug.

MANGO—
Trypetidae, Dacus frauenfeldi, Schin. in fruit.
Boisteres sp. nr. *compensans*, Silv. (*Braconidae*)—parasite of larvae of *D. frauenfeldi*.
Drosophyllidae, Drosophila punctipennis—sub-sp. *parapunctipennis Duda*. in over-ripe fruit.
Eucosmidae—Argyrploce aprobola, Meyr. on foliage.
Eugenia mallacensis—
Trypetidae, Dacus frauenfeldi, Schin. in fruit.
Drosophyllidae, Drosophila punctipennis—sub-sp. *parapunctipennis Dudo* in over-ripe fruit.
Tortricidae, Homona aestivana, Wlk. on foliage.

TOBACCO AND TOMATOES—
Capsidae, Eugytatus tenuis, Tent. on flowers—causing the blossoms to fall.

VARIOUS HOSTS—

Lepidoptera.

Noctuidae, *Serrodes campana*, Mab. and *Oxyodes ochreata*, Roth. on rembutan foliage.
Parallelia stuposa F. on Acalypha foliage.
Parallelia palumba, Guen, on citrus, on foliage.
Hyblaea fuera, Cram. on Teak foliage.
Erias fabia, Cram. and *Anonis flava* F., on "Aibika."
Sphingidae, Deilephila placida, Wlk. on *Taberne montana.*
Tortricidae, *Homona mermerodes*, Meyr. on Clerodendron foliage. *Adoxophytes* sp. nr. *melichron*, Low on peanut foliage.
Lyonetidae, Opogona laochroa, Mehr. in sugar-cane.
Cosmopterygidae, Pyroderces tripola, Meyr. in seed of pods of *Octomeles sumatrana.*
Heliodinidae, Strathmopoda sp. in ripe fruit of Madagascar plum.
Eucosmidae, Laspeyresia sp. in Carembola fruit.
Gracillaridae, Acrocercops crameralla, Snell, in fruit of *Synometra cauliflota.*
Rhyncota, Halticus sp. on beans.
Platyaspidae, brachyplatys sp. on beans.
Coccidae, Pinnaspis aspidistrae, Sign. on Maidenhair fern.

ECONOMIC BOTANIST'S REPORT.

Advisory work has of necessity taken up a considerable proportion of the available time and the usual biennial furlough lasted until 24th August of the year under review.

Since arriving in this Territory, facilities have been made available so that most of the planted areas in New Guinea have been visited, many properties three or four times. The properties on the western islands and the plantations bordering Astrolabe Bay close to Madang were visited for the first time this year. The plantations not yet covered are on the mainland coast of New Guinea from Madang to Aitape, Dampier or Kar Kar Island, the Portland Islands and part of Gasmata sub-district.

During the year, the following articles were published in the *New Guinea Agricultural Gazette*:—

(1) "Coco-nut Improvement by Seed Selection and Plant Breeding."
(2) "Fall of Mature Palms in New Guinea Plantations."

In the hands of the printer is an article on "Coco-nut Diseases Associated with Soil Conditions in New Guinea."

Apparently, the low to moderate ruling prices and the uncertainty of the future prospects of the copra market are producing one desired effect in further turning the attention of local producers to other plantation crops. The position for the Territory as a whole is, nevertheless, unfortunate, as there is not so much money available for development.

Cacao cultivation has continued to receive increased attention, which has necessitated much preliminary advice and inspection of areas intended for this crop. Undoubtedly, the provisions of the Bounties Act has also had a good deal to do with this development.

Many inquiries have been received as to the possibility of rubber planting in New Guinea. Investigations of the economic prospects of this crop are being made, as these are not clear. No local publication on the subject has yet been prepared, but detailed notes on methods of planting, clearing, &c., have been furnished to interested planters. A similar circular containing particulars of tapping and factory equipment has been supplied to those plantations where ordinary rubber, *Hevea brasiliensis*, and *Ficus elastica* (Assam rubber), was established during the German régime.

The ruling high prices and the success of the industry in Papua, where 1,243 tons, valued at £129,448, was produced last season, have been to some extent responsible for this increased interest. A more important reason, however, is that on three properties *Hevea* rubber has been established and has flourished for many years without attention, and is now being successfully and profitably tapped. The fact that heavy restrictions have made the high prices possible, is the threatening circumstance.

In practically every instance, it is the economic prospects of the various crops which require elucidating before definite recommendations can be made. The experience of the intending planter and the type of labour available has to be taken into account. Nowhere is this more apparent than on the few lowland coffee plantations here, where the only hope of bringing them to the dividend-paying stage depends on experienced management and supervision. It is for reasons of this nature, that cacao rather than coffee planting seems to be preferable for New Guinea conditions.

It is now known that high-quality *Arabica* coffee, free from coffee rust and berry borers, can be grown at high levels here, but transport facilities and the factors already mentioned will determine future developments. The Kent's Hybrid *Arabica* coffee introduced from India was established on a small scale in an isolated area on the Bainings, through the courtesy of the Catholic Mission. Seed of this high-grade coffee was harvested and sent to the high level station at Aiyura.

It is interesting to note that, as there is no coffee rust (*Hemileia vastatrix*) present here, there are four widely separated places where small areas of *Arabica* coffee are flourishing almost at sea level. The best example of this is at Mandres Plantation, where a few acres of such coffee have been grown and utilized for many years. High-grade coffee is worthy of much greater trial at high levels.

Some planters are now growing their own cover crops and in three cases seed was sold on a commercial basis, which is a desirable development.

Property Inspections.

Under an arrangement made by the Custodian of Expropriated Property with the Director of Agriculture, inspections and investigations of a number of old declining properties were made.

The main aspects of maintenance of plantation properties may be said to comprise—

(*a*) Control of pests and diseases.

(*b*) Conservation of the planted areas by cultural methods so that diminution in production is controlled.

Reference to an article entitled "A Survey of the Coco-nut Industry in the Mandated Territory of New Guinea" (see *New Guinea Agricultural Gazette*, Vol. 2, No. 2, October, 1936) and, also, various Departmental reports, outline the problems offered by the obvious decline in output of a considerable number of the older properties in this Territory. These properties very largely comprise the plantations taken over by the Commonwealth Government upon the expropriation of German colonists in 1920-21. Many of these properties are now approximately 50 years planted whilst the youngest of them is nineteen years under coco-nuts. It is obvious that properties giving a low yield of copra per acre show a high cost of production, which is particularly felt when the prices of copra are low.

Reports on the inspections made were submitted to the Department from time to time, and these reports, containing the conclusions arrived at, were passed on to the Custodian. It was found that usually a combination of circumstances, such as age of the palms, linked with soil exhaustion, lack of seed selection and care in the original plantings, and poor cultural methods, was largely responsible for the present condition of the declining properties. Some of them were originally planted all or in part on unsuitable soils, and little could be done about them.

It was also established that the solution of the difficulties is no easy matter. This is largely because soil conditions and the remedial measures which would apply to the soils of the coral atolls of the Western Islands, for instance, have little relationship to those found where plantations are situated on estuarine deposits on the mainland. The soil conditions of both these places are quite different from those of the volcanic pumiceous soils of the Gazelle Peninsula.

In practically every instance, it was possible to make recommendations for improving the planted areas though where the soil profiles are very unfavorable, very little improvement can be expected.

Increased use of cover crops, such as *Centrosema pubescens*, *Calopogonium mucunoides* and *Pueraria javanica*, such as has been long advocated by this Department, was indicated in most places.

Plant Improvement.

In view of the high variability of the population of palms in plantations, the need for a more scientific system of selection has long been apparent, and is being urged and practised by this Department. Similar variations in yield, quality and other characteristics and the certainty of isolating and breeding superior types, is the aim underlying the plant breeding and selection work on this and various other crops, carried out at Keravat Demonstration Plantation.

Regional strains of coco-nuts, the most noteworthy being the Markham Valley strain, have been isolated and are being grown at Keravat, where they are being used in the selection and breeding programme mentioned in the last annual report. There, it was also pointed out that 33 dwarf or King coco-nut palms were crossed with five selected Markham types of palms as pollen parents. The resultant crossed nuts have now been planted out in an isolated area, the crossed nuts from each mother palm being kept separate.

The Niu Luka, Malayan Dwarf cross palms, introduced from Fiji last season, are planted in the near vicinity and will provide an interesting comparison.

It was also pointed out that, assisted by the Superintendent, the best palms only were selected in both the Markham and Dwarf varieties. The Superintendent is now engaged in taking detailed records of the individual palm selections and, until this is complete, it is not posible to do any more crossing. As soon as possible, however, it is intended to artificially cross the best yielding palms within the Markham strain, so as to fix the most desirable types.

Further crossing will then be done between the selected ordinary tall coco-nuts derived from various sources in New Guinea, and the most promising selections of the varieties mentioned.

The coffee cross-breds mentioned as being successfully raised last year have been planted out for observation and selection purposes.

As mentioned in previous reports, a number of selected rubber trees growing in the Botanic Gardens were test-tapped during the season 1937-38, and all of the inferior yielding trees were cut out to allow of cross-pollination between superior yielding types only. Seed of the higher yielding remaining trees was distributed to some interested planters here, and also to the Director of Agriculture, Fiji.

Extensive seed nurseries were also laid down at Keravat with rubber seed derived from the same selected trees. The various selections were kept separate, and are now ready for planting out in plots for comparative testing.

Duplicate nurseries were made with most of the best rubber selections at Rabaul, where an area has been lined and holed in the Economic Section of the Gardens to establish a bud-wood nursery for vegetative propagation purposes.

Plant Introduction and Exchange.

During a visit to Canberra, Australian Capital Territory, arrangements were made with Dr. McTaggart, Chief Plant Introduction Officer of the Council for Scientific and Industrial Research, to take advantage of the extensive and Commonwealth-wide campaign of plant introduction. The Department is greatly interested in possible green manure and cover crops, as well as low-growing, temporary shade and over 60 introductions of these types of plants have already been made through the kind courtesy and co-operation of Dr. McTaggart.

Numerous new plant introductions were made during the year, most economic species being distributed to the experimental stations although representative specimens of various types of fruit trees were retained for the Botanic Gardens.

A fine collection of plants containing several economic species of fruiting plants was obtained from Hong Kong by the Chinese nurseryman when returning from leave.

Herbarium.

Several hundred mounted and carded herbarium specimens were added to the collection during the year. Particular mention should be made of the several specimens of grasses and legumes, collected by Mr. Wood, Inspector and Instructor, stationed in the Sepik District.

As is common in the tropics, it is most difficult to keep the dried specimens free of insect pests. It will probably be necessary to use tin containers inside the tight-fitting, storage cupboards which were obtained last year.

In collaboration with Mr. d'Espeissis, a good deal of plant identification work was carried out in the field as opportunity permitted. This work was also greatly aided by the kind assistance of Mr. J. H. L. Waterhouse, who lent some intelligent boys from Nodup School. He also supplied several lists of plants in which the native names from Nodup (Blanche Bay dialect) and other districts had been linked with botanic names of the plant identified for him by Dr. Merrill of the Harvard Arboretum. As far as possible, this work has been checked by cross-references. Other identifications were obtained direct from the Director of the Botanic Gardens, Kew, and from the Queensland National Herbarium.

Mrs. M. S. Clemens, Botanical Collector, sent in a species of grass belonging to the genus *Glyceria*, which is the first record of this genus occurring in New Guinea. She also sent in a species of *Euphorbia complanata*, Warb., which is really a Xerophytic or dryland plant spreading from India to the New Hebrides which is said to represent some botanical evidence of the original land connexions between these countries.

Diseases.

Further investigations and observations on occurrences of physiological disorders (wilts, die-backs, &c.) of coco-nut palms in New Guinea have been continued. The results of these investigations are presented in a *Gazette* ready for publication.

Special attention has been paid to "Maturation Wilts" of young coco-nut palms at the first-bearing stage, which occur from time to time in various parts of this Territory. Reports on soil analyses by the Waite Institute and the comments of their chemist, Mr. J. S. Hosking, and plant pathologist, Mr. D. B. Adam, on the nutrient status and water-relationships of the soils associated with the occurrence of such wilts on plantations at Kokopo and Namatanai have been most helpful. They have indicated the close resemblance between these occurrences, and the "Bronze Wilts" described from Trinidad, although the effects are less severe and other inter-locking, limiting factors seem to be present.

Some pathological derangements of mature palms ("Mature palm wilt"), particularly from those plantations situated on the deltaic and estuarine deposits of the Huon Gulf and Astrolabe Bay areas of the New Guinea Mainland, have been investigated in the field and described together with contributory causes.

Soil profiles and root distributions of coconut palms in such soils and, also, their natural adaptations to changing conditions, have been studied. Although many fungi such as *Thielaviopsis paradoxa*, *Botryodiplodia* spp., *Fusarium* spp., &c., have been found associated with these derangements of coco-nut palms, in every case, the soil conditions were at fault. It was found that in those areas where heavy soils liable to waterlogging exist, there is decided necessity for root adjustment in the change-over period from the wet to the dry season, which under normal conditions often has a marked physiological effect on the palms. Seasonal breeding, nut-fall, leaf-droop, frond-fall and often loss of palms, may occur, where the surface-layers are liable to waterlogging with the formation of a super-imposed water-table in the wet season, and to drying out and cracking in the dry season. This effect is greatly exaggerated either where hard pans exist or conversely, where rubble and sand layers exist.

Some occurrences of the falling of healthy, mature coco-nut palms associated with particular physical conditions of soil and sub-soil have also been investigated in the field and the findings published (see *New Guinea Agricultural Gazette*, Vol. 5, No. 1).

In parts of the Witu Island Group coco-nut palms were found to flourish and produce good crops despite the fact that their roots could not penetrate more than 18 inches at the most, owing to the presence of hardened rock-layers as the newly-derived soil was of volcanic origin and very rich and friable. In the deep pumice soils of Rabaul, a few roots of young palms were seen to have reached a depth of at least 30 feet.

It has been clearly determined that from a practical standpoint, the study of soil profiles, as to depth, presence of hard-pans, &c., has yielded much information concerning the suitability of particular areas for coco-nut cultivation. It has also proved of great value in assessing the actual potential value of plantations even where chemical data cannot be obtained.

The importance of proper cultural conditions in relation to the control of most coco-nut diseases, but particularly those of physiological origin, is most apparent. The necessity for detailed chemical and botanical research on the nutrition of coco-nut palms in relation to the soil conditions found here has also been clearly indicated.

The Director of Agriculture and other departmental officers investigated and macroscopically diagnosed true "bud-rot" on one plantation here. Microscopic examination of specimens of diseased tissue made by the Imperial Mycological Institute revealed the presence of fungus mycelium which they considered to be *Phytopthora* from measurements taken. Detailed microscopic examination of fresh specimens was later made in the laboratory at Rabaul. It was found definitely that the bud-rotting fungus *Phytopthora palmivora* was associated with the diseases. The best microscopic slides were obtained from a naturally-isolated, almost pure culture of the organism in the central tissue of the lower trunk (a most unusual site for this fungus to occur). The mature spores (oo-spores) and resting spores were unmistakable under the microscope as they showed the varying forms and the pronounced beaks characterising the spores of this fungus.

The same fungus was found associated with a case of "spear die-back" of oil palms at Keravat some time ago, but only a few palms were lost and the condition cleared up.

The bud-rot developed under flat and foothill conditions in a region of heavy rainfall in an abnormal climatic season, and even then only in areas where the palms were growing on heavy soil, liable to water-logging. A visit was made to investigate the possibility of this disease spreading to other properties. The indications are very strong that the disease would only prove serious under comparable conditions to those indicated, as the fungus can only develop in a very moist atmosphere.

It is certain that the fungus *Phytopthora palmivora* is widely spread in the Territory of New Guinea and, apart from the coco-nut palm, there are plenty of other host plants available (e.g., cacao, betel nut, *Areca catchu*, oil palm, pawpaws, *Hevea* rubber, &c.), which this fungus does attack. It would appear, therefore, that it is only under certain special circumstances that this fungus causes serious loss of coco-nut palms and probably only when a virulent strain

of the fungus is present. Strong measures are being taken to control the disease and, although there has been a loss of palms spreading over twelve months, the disease has been confined to one property.

On one coffee plantation here, improved plant sanitation, as recommended, has reduced the incidence of thread-blight (*Corticium kolerga*), die-back (*Diplodia* spp.) and root rot to a minimum, although they were formerly causing much damage.

On old properties here, where rubber was interplanted with cacao and then neglected, it was seen that root rotting fungi, *Fomes* spp., *Ustilinia* spp., *Rigidoporus microporus*, &c., have spread from the cacao to the rubber which would indicate one danger from interplanting these crops.

Eelworms or parasitic nematodes (round worms) of microscopic size are common causes of plant diseases in New Guinea.

Heterodera radicicola.—These nodular eelworms were found causing serious damage to the roots of crop and garden plants last season. They have a very wide range of hosts and are difficult to control. They were found here on tobacco, tomatoes, rice, pawpaws, *Patchouli pogostemmon*, bush-shrubs, and caused very serious damage on the garden balsams, *Impariens balsamina*, and on gerberas.

From specimens of diseased yams and slides sent, Dr. Goodey, of the Institute of Agricultural Parasitology, England, has identified *Anguillulina pratensis*, as associated with the sapronphytic eelworms, *Cephalobus striatus*, *Aphelenchoides parietinus* and *Rhabditis* spp. He recommended washing the yams for a certain period and painting their lesions with a solution of iodine in potassium iodide at a dilution of 1 in 5,000 as treatment.

The saprophytic eelworm *Cephalobus rigidus* has been isolated and identified from coco-nut fronds but, so far, no parasitic species such as occurs in the West Indies have been observed damaging the palms.

The fungus *Rhizoctonia* spp. was found causing serious damage on the tennis court lawns of the Botanic Gardens, Rabaul. The severe damage was probably assisted by pumice compaction and alteration of the soil reaction. Prompt action has been taken to remedy this by removing several inches of the surface soil and renewing with fresh soil which meant complete replacement of the lawns.

Several diseased plants were sent to the Department of Agriculture for identification. It was seen that leaf-spots due to *Cercospora* spp. were common cause of trouble with vegetable plants such as beans and frog-eye spots, *Xercospora nicotianae*, were so severe as to lessen the value of leaf tobacco for native use.

Specimens of *Diplodia* and *Botryodiplodia* fungi from rubber, cacao and coffee, were sent by request to the Agricultural Experiment Station, Florida, for comparative studies.

Numerous types of grass rusts were supplied to the University of Sydney to assist in scientific studies connected with cereal rusts.

Specimens of probable new kinds of loose smuts and flagsmut on various grasses and sedges were located and sent to Professor Zundel of the State College, Pennsylvania, for his studies on the "Smuts of the World".

THE COCO-NUT LEAF-MINER, *PROMECOTHECA PAPUANA*, CSIKI., AND ITS PARASITES.

(*B. A. O'Connor, B.A., B.Sc.Agr., Department of Agriculture.*)

In various parts of the Territory of New Guinea, chiefly on the island of New Britain, the Coco-nut Leaf-Miner has caused extensive damage to plantations and native groves. The two most serious outbreaks in recent years were those in the Rabaul district following the volcanic eruption of May, 1937, and at Lindenhafen in the Gasmata district, on the south coast of New Britain, in 1936. In the main, the pest appears to be controlled by native parasites, and the mortality among these during the eruption is believed to have been responsible for the Rabaul outbreak. The reasons for the severity of the attack at Lindenhafen are obscure, but a study of the conditions there has brought to light some interesting data.

In a severe infestation, the extent of the damage to the palms can be very great. The leaflets are completely destroyed, turning a greyish-brown colour, and giving the palms the appearance of having been scorched by fire, while in some cases the central shoot may be extensively damaged, leading to the death of the palm. Recovery is slow, and there may be a cessation of nut-production for as long as two years, the immature nuts falling to the ground as a result of the debility of the palm. Where attack is less severe, drying and curling of the tips of the fronds is noticeable, together with the elongated, brown patches due to mining of the larvae within the leaflets.

Data relating to the life history and habits of the beetles and its parasites have been compiled during the course of investigations at Manus in 1938, and at Lindenhafen, New Britain, in 1938-39. The method of rearing and observation was as follows:—

One or more pairs of newly-emerged adults were placed in wire sleeves attached to a growing palm in such a way as to contain several leaflets. The wire sleeves were cylindrical, about 18 inches long and 4 inches in diameter, and at each end were continued into cloth cylinders about 6 inches long, which served to close the wire cylinder, and render it beetle-proof. Palms of from six months to a few years old were used, as their foliage is more easily accessible. When the palm used was only a few feet high, a stake was placed in the ground a few feet away, and one end of the cylinder attached to a piece of twine coming from the end of the stake. Thus the weight of the cylinder was supported largely by the stake. When older palms were employed, a piece of tie-wire was passed along one side of the cylinder, and was attached to the mid-rib of the frond. Cotton-wool wrappings were always used to ensure that the cloth fitted tightly over the leaflets, as otherwise the beetles were able to escape. When food became exhausted, or when several egg-masses had been laid on the leaflets, the beetles were moved to fresh leaflets. Egg-masses were marked, and the development of the eggs and larvae followed up. Life histories of larvae were worked out also in the laboratory, where larvae could be carried through in leaflets kept in water, being put into mines in fresh leaflets whenever necessary.

Bionomics of *P. papuana*.

The Eggs.—The eggs, which are dorso-ventrally flattened, oval objects, are laid almost invariably on the underside of the leaflet, very occasionally on the upper surface, and are covered with excrement by the female beetle. The mound thus formed is oval, about ⅛ inch long, with a rough, biscuit-coloured surface. Egg-laying takes place in the evening, during the last hour before sundown, and the number of eggs per egg-mass is from one to six, averaging about three. In Manus, the usual number is three, and five is an extremely uncommon total, while at Lindenhafen four is the usual number, five is not uncommon, and six is very rarely met with. Before laying the eggs, the female beetle chews a furrow in the leaf surface in the spot where the eggs are to be laid, so that the young larva, on emerging, is able to enter the interior of the leaflet. The larva is unable to penetrate an undamaged leaf surface, as its head is very strongly flattened dorso-ventrally, the pincer-like mandibles working in a horizontal plane.

The Larva.—The larva is a cream-coloured grub, with strongly chitinized head and mouth-parts, golden-brown in colour. On hatching from the egg, it immediately works its way inside the leaflet, using the furrow made by the female beetle, and normally feeds straight ahead, cutting a wide track through the green matter of the leaflet, which it tears away by the pincer-like action of the jaws. Only the epidermis of the leaflet is left above and underneath the mine, and before this begins to dry, the larvae can clearly be seen feeding when a mine is held up to the light. Regular swathes of excrement are left behind in the mine as the larva advances. The average number of larvae per mine is about three, but during severe infestations twenty or thirty egg-masses may be laid on one leaflet, and several mines made by young larvae may run into one another. As many as thirteen larvae have been seen by the writer feeding abreast in a single mine. In such cases, of course, usually only a few larvae reach maturity, the majority perishing of starvation.

There are three larval instars, and at the end of each of the first two, a larval skin is cast. The fully-fed first-instar larva retires backwards down the mine, and a quiescent period of two or three days follows, during which the old larval skin is cast. Feeding then continues until the end of the second instar, when the process is repeated. On the completion of the third instar, no skin is cast, but the larva ceases feeding, and spends about three days as a resting prepupa, the latter differing only slightly in external appearance from the fully-fed larva.

The places at which feeding for each instar has ceased can often be seen in an external view of the mine. At the end of each instar, the green tissue of the leaf which the larva has been attacking dries hard, leaving a visible mark after the larva has again begun to feed, which it does by first biting through the dried tissue. The position of the larva in the mine can best be called "lying on its back", the dorsal portion of the body always being towards the ground. This position is maintained by the pupa, so that normally the newly-hatched adult beetle is placed with its mouth-parts in proximity to the upper surface of the mine, and hence it bites its way out through this surface. When a larva is being examined outside the mine, the dorsal surface can always be distinguished from the ventral, as the larva bows itself backwards, the inner portion of the curve being formed by the dorsal surface.

Prepupa and Pupa.—When the resting stage of the prepupa is completed, the old skin splits along the dorsal portion of the thorax, and the pupa forces its way out. A series of convulsive movements by the pupa sloughs off the old skin until it comes to rest at the dorsal end of the pupa, forming a small attached lump, the most noticeable portion being the chitinized head and mouth parts of the old larval skin. Later on, this lump falls off the pupa, leaving it quite free.

The colour of the pupa, when it is first formed, is creamy-white, but it quickly darkens until it reaches a golden-brown tint. Later, eyes, mouth-parts and elytra become black. It is armed with rows of spines on the dorsal surface of the abdominal segments, and these enable it to move freely within the mine by gripping the epidermis of the leaf as it progresses by alternately doubling and straightening itself.

Adult.—The newly-emerged adult is pale yellow in colour, with dark patches on the distal portion of the elytra. The colour gradually deepens, until finally the general colouration is golden-brown, with the prothorax and distal third of the elytra a deep bluish-black. A colour variation occurs in Manus, the beetles in that locality having much paler colouration and markings.

After emergence from the pupa, the adult remains for about two days in the mine before biting its way out. It lies on its back in the mine, with its feet grasping the cast pupal skin. When emerging from the mine, it bites a semi-circle in the epidermis, almost invariably in the upper surface of the leaflet, and forces its way out.

The beetle feeds mainly on the distal third of the leaflets, preferring the older fronds to the younger. Almost all the feeding takes place underneath the leaflets, the green tissue being eaten in fine lines running parallel with the mid-rib. The beetle rests on the leaflets with the long axis of the body parallel to the mid-rib, and turns its head sideways for each bite, so that the mandibles can grasp a portion of the green tissue of the leaf from between the fibres. The damage caused by adult feeding is much more extensive than that due to the larvae. The distal portions of the leaflets become dry and curled, and, where infestation is severe, the whole palm has a brown, scorched appearance.

Copulation occurs frequently, and copulating pairs show a tendency to be gregarious. Pairs of beetles which have been kept under observation have been seen to copulate almost daily over a period of two to three months. Seven to ten days after the first copulation, the females begin egg-laying, and continue for some months. They do not lay more than one egg-mass per day, the usual rate being about two egg-masses in three days for the first month or two, after which it is lower.

Adult beetles can live as long as five months, and probably more. Of those kept in captivity, none was kept until it died of natural causes. They either escaped, or were still living when observation had to be discontinued. One female was kept at Lindenhafen for 160 days and a male and female for 140 days. Copulation was noticed with beetles 135 days old.

It would appear that the female can lay about 80-100 eggs, that is about 30 egg-masses at Manus, and 25 at Lindenhafen. The pre-oviposition period is commonly about four weeks or a month, 24 days being the shortest period noted. At Manus, life-history observations were interrupted before oviposition was

completed, but the average oviposition by four females was 22 egg-masses in 41 days. At Lindenhafen it appeared that there was a break in the continuity of egg-laying. Thus, two females under constant observation laid eggs as follows:—

Emergence of adult from mine.	First oviposition period began.	First oviposition period ended.	Second oviposition period began.	Second oviposition period finished.
	16 Egg-masses		4 Egg-masses.	
A.—10th to 11th February	10th March	6th April	8th May	22nd May.
	28 days	27 days	32 days	14 days
	13 Egg-masses.		11 Egg-masses.	
B.—14th February	14th March	15th April.	27th May	27th June
	28 days	32 days	42 days	31 days

It will be seen that the total period of oviposition for A is 73 days, with a break of 32 days, and for B 105 days, with a break of 42 days.

Figures for the developmental period of eggs, larvae and pupae are given below:—

Eggs.—At Manus, the incubation period varied from 13½ to 16 days, with an average of 15 days. At Lindenhafen, the range was 13 to 15 days, with an average of 14 days.

Larvae and Pupae.—Data are presented in the following table (the figures are in days):—

——	A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.
First stadium ..	9	8	8	5	5	5½	5	6	6	6	6
Rest	3	2	3	2½	2	3	3	3	3	3	3
Second stadium ..	5	5	5	3	3	2½	3	8	8	8	13
Rest	3	3	3	2½	3	3	2½	2	2	2	3
Third stadium ..	8	10	10	7½	6	6	4	6	7	8	12
To emergence of adult ..	16	15	15	15	15	15	15	15	15	15	15
Total, egg to adult	44	43	44	35½	34	35	32½	40	41	42	52

Mines A to G inclusive were under observation on growing palms at Manus. Mines A to C were in mature leaflets, while mines D to G were in leaflets of a palm about six months old. It will be noticed that there is a marked difference in the developmental period of larvae from these two sets of mines. H to K are single larvae from the same mine at Lindenhafen. These were reared in the laboratory on leaflets kept in water. Larva K, it will be noticed, had a very much longer developmental period than larvae H to J. The period of 15 days from the end of the third stadium to emergence of the adult from the mine is very consistent, and is made up normally of a prepupal period of 3 days, pupal 10 days, and resting adult two days.

At Lindenhafen, where in certain localities there was a definite break in the normal overlapping of life-history stages, field observations indicated that the length of a generation was three months. This was the period which elapsed

between first appearance of adults in one generation and first appearance in the next. However, the average length of a generation would be longer, calculating from the middle of one oviposition period to the middle of the next. On this basis, the average length of a generation could be estimated as follows:—

	Manus.	Lindenhafen.
	Days.	Days.
Incubation period	15	14
Larval period	28	30
To emergence of adult	15	15
Pre-oviposition	45–50	60–70
Total	103–108	119–129

Hence there would be between three and four complete generations each year. If we put 28 days as the pre-oviposition period (i.e., the period from emergence of adult to first egg-laying), we have just under three months for the generation.

The break in overlapping of generations at Lindenhafen has been mentioned above, and a similar state of affairs appears to exist in the Rabaul district. Having regard to the long period during which oviposition takes place, complete overlapping would be expected to prevail, as, even after a temporary setback, this condition could be produced in one generation. In the beginning of December, 1938, when the writer first went to Lindenhafen, only eggs and adults were present. Later on, only larvae were to be found, then larvae, pupae and adults, then again adults only, and finally adults and eggs only. This was roughly the position during the eight months during which work was carried out at Lindenhafen, and apparently it had been so for a considerable time previously. The break was not absolutely complete, as a very occasional larva might be found during the adult and egg period, but generally speaking, it is true to say that overlapping covered a period of only a month. In other words, it would be possible to have all stages of larvae in the field at one time, or pupae and adults, or adults and eggs, &c., the least advanced stage commonly found being only one month's development behind the most advanced stages. Hence it seems that the longevity of adults in the field may be much shorter than in wire sleeves, as otherwise adults would have been present in considerable numbers at all times. The activities of predators and fungi in reducing the adult population appeared by no means sufficient to bring about the observed conditions. In the case of the eggs, larvae and pupae, the destruction of eggs by internal parasites and by ants is thought to be the main factor in reducing overlapping. This subject will be mentioned later.

Host-plants of *P. papuana*.—Apart from the coco-nut palm, only two other plants have been noted as hosts of *P. papuana*, namely, the sago palm, *Metroxylon sago*, and the oil palm, *Elaeis guineensis*. On the former, the insect can go through all stages of its life-history, but this is apparently not so on the latter. Eggs are laid on it during severe infestation, but the larvae die after the first day or two of feeding.

Parasites and Predators of *P. papuana*.

Pleurotropis parvulus.—This Eulophid had been introduced from Java to Fiji and the New Hebrides to control other species of *Promecotheca*, and had been outstandingly successful. Hence it was decided that it should be imported into the Territory. In October, 1938, a colony arrived in good condition from Fiji, coming from Sydney by mail-plane, Messrs. W. R. Carpenter & Co. Ltd. having given every assistance with the introduction. The parasites were bred up in Rabaul, and distributed in the Rabaul district, Manus, Talasea, Pondo and other localities. At the end of November, the writer was sent with a colony to Lindenhafen, where *P. papuana* was present in very large numbers at the time. Breeding and distribution of the parasite were carried out in this district (Gasmata) until the end of July, 1939, by which time *P. parvulus* was firmly established at Lindenhafen. Daily collection of *Promecotheca* was carried out, so that a check could be kept on the progress of the parasites in the field. It was found that two weeks after the initial liberations, parasitized larvae and pupae could be found on the site of liberation, and even as much as 200 yards away from this point. A gradual increase was discernible in percentage of parasitism in the field, as is shown by the figures given below. Percentages were based only on mines which contained healthy larvae, pupae or adults of *Promecotheca*, or larvae and pupae containing *P. parvulus*, all those from which *P. papuana* or *P. parvulus* had emerged being excluded. Data are appended—

——	Mines containing Parasitized Individuals.	Total Mines.	Percentage of Mines containing Parasitized Individuals.
			Per cent.
6th to 22nd June, 1939 ..	18	414	4.3
23rd to 30th June, 1939 ..	10	451	2.2
6th to 30th June, 1939 ..	28	865	3.2
1st to 14th July, 1939 ..	33	872	3.8

Accurate counts are not available for the latter half of July, but judging from the results obtained from the inspection of several hundred mines, the percentage of parasitism appeared to have jumped rather sharply to the vicinity of 7 per cent. Mines were very few at this period, the average being probably only one or two per palm. In October, counts of mines sent to Rabaul from Lindenhafen showed a 50 per cent. parasitism of mines.

In the Rabaul district, possibly due to the generally drier and finer weather, *P. parvulus* seems to have multiplied much more rapidly than at Lindenhafen. Most of the liberations around Rabaul and Kokopo were made early in 1939, and by August parasitized larvae and pupae could be found in numbers by most casual inspection. At Wangaramut Plantation, for instance, between 200 and 300 mines were opened, and every one of these contained one or more parasitized larvae and pupae. Other plantations on which the parasites are well established are Ralabang, Ulatava, Keravat and Pondo, showing that its distribution is wide.

Method of Breeding of *P. parvulus*.—A very satisfactory method for bulk breeding is as follows:—

Into a large mine, from 20 to 40 prepupae or newly-formed pupae are placed. The ends of the mine are cut and closed with wire clips, and the mine is then placed in a glass tube about 8 inches by 1½ inches with 100 to 200 *P. parvulus* (i.e.

five P. *parvulus* per individual *Promecotheca*) and left for two days. Food is provided in the form of honey very slightly diluted with water, which can be placed on a small piece of blotting paper stuck to the side of the tube, or on the upper surface of the mine in very small droplets. At the end of two days, the prepupae and pupae are removed, and stored in a glass tube 6 inches by 1 inch. If the climate is moist, the tube should be lined with blotting-paper, and adult beetles emerging from unparasitized pupae should be removed daily, otherwise there is a risk of sweating, and consequent fungus attack on the parasitized individuals. The same individuals of *P. parvulus* can be used three or four times for oviposition in fresh lots of *Promecotheca*. Prepupae and pupae are preferred to larvae, as the latter have to be fed before and after parasitism, a process which occupies a great deal of time. These methods were used at Lindenhafen, and produced from 1,000 to 1,500 well-grown wasps per day. Superparasitism was found to be negligible. The developmental period of *P. parvulus* from parasitism to emergence of wasps, was found to be 17 days in Rabaul and 19 days at Lindenhafen, the difference being due to higher mean temperatures at the former locality.

In this connexion it was calculated that the developmental zero for *P. parvulus* was approximately 55° F. (12.8° C.). To determine this figure, parasitized larvae and pupae of *P. papuana* were placed in a refrigerator where the temperature varied from 56° F. to 70° F., averaging between 61° F. and 62° F. Temperatures were taken every three hours in the refrigerator and in the laboratory, and the developmental period for *P. parvulus* in these two situations was noted. From these data the figure for developmental zero was calculated, the results of three trials conducted at different times being 55.5° F., 54.7° F. and 56.7° F.

Description of *P. parvulus*.—The adult wasp is a black, robust insect, about 1/16th inch in body-length. The three proximal tarsal joints on each leg are white, the fourth joint, like the tibia and femur, being black. Males are smaller than females, and have a greenish sheen on the ventral portion of the thorax, which is not present in the female.

Bionomics.—The egg of the wasp is laid, from outside the mine, into the larva, prepupa or pupa of *P. papuana*, the ovipositor of the female penetrating the epidermis of the leaflets in order to reach the host. Oviposition is usually carried on from the under-surface of the leaflet. Where the host is a well-grown, third-instar larva, a prepupa or a pupa, the developmental period of the parasite is shorter than when a first-instar or second-instar larva is the host. At Lindenhafen, 19 to 21 days was the usual period, but some individuals occupied as much as 27 days even in large third-instar larvae. In the second-instar larvae, the period was from 21 to 23 days, with some individuals occupying up to 30 days. At Rabaul, 17 to 19 days was the usual period when large larvae were the hosts. When the life-cycle covers 19 days, the larval period is about eight to nine days, and the pupal period 10 to 11 days. The pupae, when first formed, are white, but darken quickly, until they are finally quite black. The skin of the host turns black about six or seven days after oviposition, in the case of third-instar larvae. When prepupae are attacked by the parasite, they almost invariably reach the pupal stage before dying, and when the pupa darkens it does not become black, but a greyish-brown. Parasitized larvae always feed more voraciously after eggs of the parasite have been laid into them, and in the case of first or second instar

larvae, the subsequent feeding period may be as long as 14 days. Feeding by the parasite larvae goes on entirely within the host, and when prepupation occurs, the pupae are packed inside the dried larval or pupal skin.

When fully developed, the adult parasites cut holes in the dry skins of the host, and emerge into the mine, where they then cut holes in the upper epidermis of the leaflet, and escape into the open air. If the portion of the host skin in which the hole is made is pressed against the epidermis, the parasites bite their way straight out, and do not enter the body of the mine. The number of holes made in host and mine varies from one to six.

Superparasitism.—This has seldom been observed in nature by the writer, but in laboratory breeding, when parasites are placed in a tube with an insufficient number of hosts, it is of common occurrence. If the degree of superparasitism is moderate, the parasites complete their development, but emerge as stunted adults. If it is extreme, development is not completed, parasite larvae and host shrivelling up completely. In one shrivelled third-instar larva, 180 *P. parvulus* larvae were counted. It appears that up to 40 good-sized wasps can develop in a prepupa, pupa or mature larva.

Eurytoma promecothecae.—This parasite was recently described by Ferrière from specimens collected in the Rabaul and Gasmata districts. It is a black wasp, about 1/10th of an inch in body-length, with the distal ends of the tibia yellow, and the tarsi white. The antennae of the male differ from those of the female, the funicle joints of the former being hairy and irregular in shape, while those of the latter are smooth and rounded.

E. promecotheca has been so far recorded only from New Britain, and it appeared to be the main factor in controlling the outbreak of *P. papuana* which occurred along the north-coast road in the Rabaul district subsequent to the volcanic eruption of May, 1937. It would appear that the outbreak was due largely to destruction of a great proportion of the local parasites by the deposits of ash which fell on the plantations in this area, followed by torrential downpours of rain. It was noticeable that those plantations which had suffered most from the ash and the cloudburst were subsequently the most severely attacked by *P. parvulus*.

E. promecotheca is an external parasite of the larva of *P. papuana*, each of the three instars being attacked. The parasite larvae are voracious feeders and, attaching themselves to the sides of the *Promecotheca* larva, they suck its body-fluids until they are fully fed. Feeding is especially heavy during the last day, when the host larva shrinks from almost normal size to a shrivelled husk. The host larvae are paralysed by the adult wasp when the latter lays its eggs, so that they are unable to rid themselves of the parasite larvae.

When the larva of the parasite is fully fed, it moves along the mine and pupates, the pupa being attached to the wall of the mine by a drop of excreta and the cast larval skin. Its colour is at first light yellow, later becoming black. The developmental period, from oviposition to emergence of the adult wasp, is 19–21 days at Lindenhafen, 17–20 days at Rabaul. The adult cuts a hole in the epidermis of the leaflet, usually on the upper surface, and emerges. Maximum longevity of adults in the laboratory was 60 days when not provided with hosts, and 35 days when permitted to oviposit into larvae.

Derostenus sp.—This parasite of the larvae of *P. papuana* occurs widely throughout the Territory, having been recorded from Lindenhafen, Rabaul and Manus. It has not yet been specifically determined, but belongs to the family *Eulophidae*. The adult is of a metallic-green colour, with coxae, tibia and tarsi of all three pairs of legs white. Body-length is about 1/16th of an inch. The adult has a very characteristic habit of running rapidly sideways and of standing on the leaf swaying its body to and fro.

This insect is an internal parasite of the larvae of *P. papuana*. The host does not feed after oviposition by the parasite, and the parasite larvae develop inside the body of the host, which gradually assumes the appearance of a transparent envelope enclosing the parasite larvae. When fully fed, these latter bite their way out of the skin, and pupate in the mine, the pupae being attached to the walls of the mine by a drop of excreta and the cast larval skin. The skin of the host remains distended and transparent. The parasite pupae gradually become black in colour, and normally, the adults emerge and bite their way out of the mine 18–21 days after oviposition by the parent generation. Larval and pupal periods at Lindenhafen were approximately equal.

In the laboratory, *Derostenus* failed to oviposit in prepupae and pupae, and no larvae parasitized by it ever reached the pupal stage. However, in the field it was not uncommon to find pupae parasitized by this species, their appearance being very similar to that of pupae attacked by *P. parvulus*. Three adult females, supplied regularly with food and host larvae for oviposition, lived 25, 26 and 32 days in the laboratory, laying eggs until a day or two before death. When *Derostenus* and *P. parvulus* females were allowed to oviposit into a host larva at the same time, *Derostenus* always won in the competition for food, and only *Derostenus* adults later emerged from the parasitized larva.

Closterocerus splendens, Kow.—This Eulophid is about 1/25th inch long, with brilliant metallic-green body and banded wings. It was originally described by Kowalski from the New Hebrides as a parasite of the larva of *Promecotheca opacicollis*, Gestro., but in New Guinea, where it has been found in the Manus, Rabaul and Gasmata districts, it is an egg-parasite. The bionomics of this species have not been extensively studied, but the developmental period from egg-laying to emergence of adult is about 21 days. One parasite develops in an egg of *P. papuana* and an egg-mass may have one or more parasitized eggs. When the parasite is fully developed, it cuts a small hole through the covering of the egg-mass, through which it emerges.

As has been mentioned earlier, *C. splendens*, and to a lesser degree the egg-parasite *Anastatus* sp., are deemed the main factors causing the break in over-lapping of generations in Gasmata and Rabaul districts. At the beginning of egg-laying in one generation of the beetle at Lindenhafen, an attempt was made to estimate the percentage of parasitism of the eggs at different periods. Egg-masses were collected from widely separated portions of the plantations, and the leaflets on which they were laid were kept in water for ten days to allow any parasites which might be in the eggs to develop to a point where they were easily distinguishable. Laying of eggs in the field by this generation of beetles began about 20th May, 1938, and hatching of parasites from these eggs began about 9th June, 1938.

Results of the examinations of eggs collected at three different times are as follows:—

Collected 6th June	30 per cent. eggs parasitized.
Collected 20th June	80 per cent. eggs parasitized.
Collected 3rd July	100 per cent. eggs parasitized.

Hence we see that about six weeks after egg-laying began, 100 per cent. of the eggs were parasitized, and this could explain the restriction of over-lapping of generations to about that period.

Anastatus sp.—This Encyrtid is about the same size as *C. splendens*, and is of a brilliant blue-black colour. It has been hatched from the eggs of *P. papuana* in the Manus and Gasmata districts.

Other Internal Parasites.—One other parasite of the larva, whose habits are similar to those of *P. parvulus*, has been found in Manus, and from the same district and Rabaul, two species of minute hyperparasites of *C. splendens* have been recovered.

Predators.—The pentatomid bug, *Amyotea reciprocus*, Wek., has been recorded as a predator of the adults of *P. papuana* in the Rabaul and Gasmata districts. The adult bug impales the beetles on the end of its extended proboscis, and sucks up the body fluid at leisure.

Ants.—These destroy large numbers of eggs and larvae, and a few adult beetles. Vast numbers of eggs are eaten by *Pheidole megacephala*, Fabr., a small, reddish ant, whose workers have greatly enlarged heads. *Technomyrmex detorquens*, Walk., a black, active ant, with somewhat heart-shaped abdomen, which builds protective galleries under the palm leaflets, using earth-coloured fluff from the crown of the palm, has also been seen to devour eggs.

Various species of ants also attack the larvae and pupae, biting holes to gain access to the mines, or entering through holes previously made by earwigs. *Pheidole megacephala* is again one of the invaders, and other species which attack larvae and pupae in the mines are *Tetramorium guineense*, F., *Monomorium floricola*, Jerd., *Monomorium minutum*, Mayr., and *Tapinoma melanocephalum*, Fab. *M. minutum* frequently forms its nest within the mine of *P. papuana*. At times, as many as 50 per cent. of the mines collected in the field had been attacked by ants, and up to 30 per cent. of the larvae and pupae destroyed.

The Kurukum Ant.—There has been much discussion in the Territory as to the value of the Kurukum Ant, *Oecophylla smaragdina*, var. *virescens*, F., as a controlling agent for *Promecotheca papuana*. Some planters claim that this ant, if present in sufficient numbers, will prevent extensive attacks by the pest. The writer's observations at Lindenhafen provide no support for this view, as the Kurukum was present on the plantation in very large numbers, but was unable to prevent or control the depredations of *P. papuana*. On no occasion has the ant been observed to attack eggs, larvae or pupae of the beetles, and the latter have been observed laying eggs freely on the leaflets of fronds which carried hundreds of Kurukums. The ants have occasionally been seen attacking the adult beetles, and carrying them off to their nests, but these activities are negligible from the point of view of control. It has, however, been noted that certain palms which

have an exceptionally large number of the ants are sometimes less severely attacked than the surrounding palms. A point of importance regarding the habits of *O. smaragdina* is that it exerts a harmful influence by cultivating and protecting aphids, scale-insects and mealybugs.

Earwigs.—There is a species of earwig commonly found in the crown of coco-nut palms in this Territory, which has not yet been identified. At Lindenhafen, it was found that this earwig commonly entered mines of *P. papuana*, usually making longitudinal slits in the upper surface, and at other times chewing openings in the upper or lower surface. Observation in the laboratory gave no indication that the earwigs attack larvae or pupae of the beetle, and it is thought that they enter the mines for scavenging purposes. Holes made by them provide points of entry for ants.

Fungi.—During the south-east season in the Gasmata district, from April to October each year, the rainfall is very heavy, up to 70 inches in one month having been recorded, and there are many dull, cloudy days. Under these conditions, the adult beetles are freely attacked by a fungus which has been identified as *Synnematium jonesii*, Speare. Many adults were found dead and fixed to the upper or under surface of leaflets by the white mycelium of the fungus, which also radiates out in all directions from the dead beetle, and covers the body with weblike hyphae. The fungus is not considered to be of great economic importance, as its controlling effect on *P. papuana* appears to be slight.

Bacteria.—Third-instar larvae of *P. papuana* are frequently found dead in mines, and have the appearance of having been killed by bacterial attack. Their coloration is black, and they lie extended in the mine, the body contents being a black slime. Like the fungus, this bacterial attack is apparently of little economic importance.

Death of Larvae from Unknown Causes.—During heavy infestations at Lindenhafen, it has been noticed that there is often a high mortality among first-instar larvae. The larvae are found at the head of the mine, in the feeding position, their bodies being flattened and extended, and normal in colour, showing no sign of bacterial or fungal attack, though there is frequently a blue-mould on the surface of the mine. The cause of this mortality is not known.

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A BALANCED PLANTATION.

(By F. C. Swinbourne, Kieta.)

The plantation which produces only one product is much exposed to market fluctuations which are beyond the control of the planter. This risk is diminished by a diversity of crops, as it is very unlikely that the market will prove unfavorable for all the crops at the same time. The diversity of crops also lessens the risk of a total loss due to pests or climatic disturbances.

It is also difficult to meet the heavy seasonable labour requirements that are necessary with such crops as coffee and cacao except where plenty of casual labour is available. With indentured labour there will be either a surplus during the slack period and, therefore, excessive expenditure, or there will be insufficient labour during the busy season and produce will be lost. By combining such crops with a sufficient area of coco-nuts, an adequate labour force can be permanently engaged, and the copra output will not be seriously affected if this portion of the plantation is periodically neglected during the short periods when the whole labour force is required for the other crops. By stocking some coco-nut areas with cattle, the maintenance costs of the area can be considerably reduced, and, at the same time, fresh meat becomes available.

No hard and fast rules as to the areas to be devoted to each crop can be made, as these must be based on productive costs, but, in general, the areas are proportioned in such a way that any one of the crops can with a fair market cover the running expenses of the whole plantation.

By proper selection of plant, a further economy can be made in cacao driers, and fermenting tanks can be so chosen as to be equally suitable for coffee, although most coffee driers are unsuitable for cacao (Gordon cacao drier). Cement coffee tanks fitted with removable wooden linings are suitable for cacao. The one grading machine does for both crops, only the screens being changed.

This is the system of agriculture adopted in the New Hebrides.

ENTOMOLOGICAL NOTES.

CALCIUM ARSENATE AS AN INSECTICIDE.

The use of calcium arsenate is not nearly as dangerous to man and animals as that of Paris green; it does not possess the caustic characteristics of the latter, but it is undoubtedly attended with a certain amount of danger. Hence, precautions should be taken to prevent the material being swallowed, and also to prevent, as much as possible, the inhalation of the dust in breathing. Absorption through the skin may also take place, and therefore excessive handling of the poison should be avoided. This danger can be reduced by frequent washings. If calcium arsenate is properly made it will not injure plants. In case any burning or scorching of the leaves should be noted, the use of this material should immediately be discontinued, as a comparatively small amount of leaf-burning may easily induce a serious amount of fruit-shedding.

It has been found that, with experienced operators handling the dusting machinery, satisfactory results can be secured from the use of about 5 lb. of calcium arsenate per acre for each application, but a new operator will generally have to be supplied with about 7 lb. per acre, which figure ought to form the basis of calculations.

PREPARATION OF REPTILE SKINS FOR EXPORTATION.

(By R. C. Hutchinson, B.Sc., Department of Agriculture.)

With the present low price of copra, many planters are seeking a new source of income which will not involve them in any initial outlay but which will bring in quick returns. New Guinea is a rich source of reptile skins—lizard, snake and crocodile—for which there is a ready and steadily increasing market. Crocodile skins have been in demand for many years but the lizard and snake skin industry is comparatively recent. Fifteen years ago, reptile skins were used only in the manufacture of luxury articles, the chief use being for the upper leather of high-priced shoes, but to-day reptile skins are used in the production of all types of shoes, bags and fancy leather goods.

At one time it was thought that the use of reptile skins was a matter of fashion, but time has proved otherwise. Because of the wide variety of finish and colour of which they are capable, they provide wide scope for change of fashion. Reptile skins have distinct advantages over sheep, calf or goat skins in that they are stronger, have a good variety of pattern and have better drying and staining qualities.

The collection of reptile skins is organized on a commercial basis in India, Ceylon, Dutch East Indies, Africa, Siam, Brazil, the Philippine Islands and Nigeria, and in some of these countries skins are selected and graded before being exported. From time to time, attempts have been made to propagate captive reptiles for commercial purposes, but generally with little success. In Melbourne, the Government keeps a large number of snakes which are "milked" regularly for their venom.

Preparation of Reptile Skins for the Market.

Crocodile Skins.—Only the belly part of the skin is usable for leather, the hard bony scutes on the back being of no value. The belly part of the skin, including head, whole of the tail and legs, must be taken off at the fullest possible width, leaving about two rows of scutes on each side of the skin. In taking off skins, cut as near to the middle of the back as possible over the legs so as to allow maximum width of skin at the legs; that is, the skins when properly taken off should be as wide at the legs as in the centre of the body. The leg portions should also be left as long as possible, and cut exactly in the middle of the large scales on the top of the leg. In taking off skins, great care must be taken to avoid butcher cuts and spear-holes, as a skin damaged in this way may lose 20 per cent. of its value. All flesh must be carefully removed, the skins properly washed, drained and thoroughly salted.

It is best to ship them in barrels, although bags or bales are suitable. The belly part of the skin must never be folded down the middle. Skins should have the soft part of the sides and legs folded in, keeping the belly flat. When shipping in bags or barrels, the skins after folding must be rolled with the scales outwards, and tightly packed. Only heavy bags should be used, which must be well fastened. If put in bales, the soft part of the sides must be folded in with the flesh outwards, and packed so that the body part will be flat. The bales should be covered with bagging so as to prevent damage to the skins. When shipping in bales, skins must never be folded with the scale side outwards, as this side would be exposed to possible damage during transit.

Snake and Lizard Skins.—Snake skins should be cut down the belly, while lizard skins should be cut down the belly with the tails cut down the back, the heads and legs being opened out so as to obtain maximum spread of skin. The only exception to this is in the case of lizards, which have a fringe down the centre of the back.

After the skin has been removed it should be carefully washed, great care being taken to remove all flesh.

Skins should preferably be shipped in the dry condition, and should be carefully stretched and staked out to their full natural width, great care being taken not to overstretch the skin, which must then be dried in the shade. Dry skins can be packed in cases or bales and the use of napthalene is recommended as a precaution against insect damage. Before drying, it is an excellent idea to put the skins through an arsenic wash to minimize the possibility of insect damage.

Alternatively to being shipped in the dry condition, they may be shipped in the wet salted state, when plenty of ordinary common salt is used. In preparing salted skins it is preferable to first sprinkle the skins with coarse salt, stack them and allow them to drain for twelve hours. They should then be packed in barrels, flesh to grain, with a plentiful application of finely-crushed salt between the skins.

Snake and lizard skins over 8 inches in width bring the best price, although it is impossible to obtain some snake skins over 4 inches. Their value depends upon distinctive markings and grain.

The Department will be only too glad to deal with any inquiries on the further preparation of reptile skins for commercial purposes.

CHEMICAL NOTES.

On the 11th September last, an Agricultural Chemist was appointed to the Department of Agriculture. Since then the Administration has built a chemical laboratory, a balance-room and a store for his use. The necessary apparatus and reagents for the carrying out of general analytical and soil chemistry have been ordered from overseas, but because of war conditions it may be some time before they arrive. In the meantime, the chemist has been engaged in field work and in doing a number of analyses of tinned meats, grasses and legumes. The latter work was carried out at the Health Laboratory at Rapindik. The results of the analyses of nine brands of tinned meat are given hereunder. Six tins of each brand were sampled—

	Water.	Protein.	Carbohydrate.	Fat.	Ash.
	%	%	%	%	%
Maximum	72	21	5	42	2.3
Minimum	42	11	1.7	11	2.0
Mean	58	15	3	22	2.1

TREATMENT OF WOUNDS IN HORSES AND CATTLE.

(*J. A. Ewen, junr., Department of Agriculture.*)

When treating animal wounds it is not always necessary or desirable that they be suturated or stitched. In fact, many wounds heal more quickly and cleanly if treated as open wounds.

These open wounds should be kept clean with antiseptic washings only when they are moist, suppurating or discharging. As soon as the wound appears to be drying up, it is preferable to change the treatment to dry dressings. These may be the application of tincture of iodine, or some methylated spirit lotion, such as 1 per cent. picric acid in methylated spirits or, better still, in rectified spirit, followed by the application of a powder (e.g., boracic powder) and loosely covered with a flap of clean cloth to prevent interference from flies and dust. Such a dressing should be repeated two or three times a day.

A wound in the canon or some area not protected with muscle cannot be sutured, on account of the tenseness of the skin at such a part. Here it would be better to use a large syringe and wash out the wound twice daily with clean water and a little antiseptic, afterwards drying with a cloth and applying iodine and boracic powder. The continued use of iodine will prevent the formation of excessive proud flesh.

In cases of severe haemorrhage, it is necessary to tie off the injured blood vessel. To do this, first wash the blood away in order to locate the severed vessel and then grasp it in a pair of artery forceps, so as to stop the bleeding. In the absence of proper forceps, a pair of tweezers may serve the purpose. A suture should then be placed around the vessel. If no silk is available, several strands of horsehair well soaked in spirit can be used.

Haemorrhage from a vessel in the leg could be controlled by placing a tourniquet around the limb; above the part in the case of a severed artery and below the part in the case of a vein. The tourniquet or ligature may be left in place for twenty minutes or more, depending on its tightness. If it has not stopped the bleeding when it is released, it must be re-applied after having allowed a little blood to flow through the tissues first. A tourniquet left too long may do serious damage.

Sometimes a bleeding vessel may be checked by using a silk thread on a needle and passing it through the skin and subcutaneous tissue and in so doing encircle the bleeding vessel and then tie it off. The suture should be removed in four or five days.

Foot injuries are usually in the nature of punctures. The seriousness of the wound depends upon the depth to which the foot has been punctured, and the position and angle of penetration. Around the point of the frog is always a dangerous place, because the navicular joint may be involved. The posterior part of the frog is always a less dangerous place for a puncture, as this can only involve the spongy frog or plantar cushion where infection is not so serious.

A nail wound in the sole of the foot should be opened up with a knife, and packed with wool soaked in pure carbolic acid. Subsequently, daily dressings should be made with 10 per cent. formalin in glycerin.

Injuries to the coronet may be serious by reason of the fact that a deformed hoof will result if the contour of the coronet is broken. Injuries should, therefore, be carefully treated twice each day. Suturing in this situation is desirable or, if it is impracticable, a tight bandage may be employed to hold the loose tissues in place. Zinc ointment can be recommended for coronary band injuries, provided the part is swabbed with spirit before each application and protected from dust and mud with a covering of cloth.

Broken knees are classified into first, second and third degree, depending on the extent of the injury. The first degree injury involves only a lacerated wound of the skin; second degree involves laceration of the skin with contusion of the tendons and cartilages underneath, whilst third degree involves these structures and the bone and joints as well. Treatment must be intensified according to the degree of the injury. In first degree cases, wash well and then use zinc ointment twice daily. In second degree cases, suturing may be desirable together with a spirit lotion and wound powder. In third degree cases, it may be desirable to have the animal destroyed, as an open joint usually leads to a permanent stiffness. If treatment is to be carried out, the joint should be syringed out six or eight times daily with "Eusol", flavine or hydrogen peroxide. In all cases of broken knees and where a pure water supply is available, syringing can be recommended, and this can be followed by the application of the selected antiseptic.

Eye injuries require bathing with warm water and boracic powder twice daily to keep the part clean. Then dry carefully. If the lid of the eye is injured, apply freely yellow oxide of mercury ointment. If the globe of the eye is involved, the cornea or glassy surface will assume a milky or frosted appearance. This calls for 10 per cent. "Argyrol", which can be placed in the eye twice daily with an eye dropper. Cheaper lotions are: 10 or 20 per cent. silver vitellin, 2 or 4 per cent. zinc sulphate, or 1 per cent. silver nitrate.

If the contour of the lids is broken, an attempt should be made to suture the torn edges into correct position, so as to prevent deformity. When treating the eyes of horses, a twitch should always be placed on the nose as restraint. A quiet animal may put up with regular treatment for a day or two, but will eventually object and become troublesome.

BANANA VINEGAR.

Peel the ripe bananas and place them in a jar or large vessel. Pour off the juice each day as it accumulates until there is only the coarse spongy debris left. Strain the juice through a thick piece of brown calico (the calico must be washed first), and let it stand until turned to vinegar. The vessel that holds the juice should not be corked, but have a piece of thin muslin tied over its mouth to let the air in and keep insects out. The time for the juice to become good vinegar depends on the condition of the bananas used. Indifferent fruit makes poor vinegar. A common way to make bananas or mango vinegar is to fill a corn bag with the ripe fruit and hang it over a wooden tub to collect the juice, but the flavour of the vinegar is not so good as if a jar or enamelled vessel were used.—*Jamaica Agric. Society Journal.*

NOTES ON THE COCO-NUT LEAF HISPA, *BRONTISPA FROGGATTI*, SHARP, AND ITS PARASITES.

(*B. A. O'Connor, B.A., B.Sc.Agr., Department of Agriculture.*)

During August of 1939, colonies of *Tetrastichodes brontispae*, Ferr., a *Eulophid* parasite of the larvae and pupae of *Brontispa froggatti*, were imported from the British Solomon Islands. Since then, breeding and distribution of the parasite have been carried on, and at the same time some observations have been made on the bionomics of *B. froggatti*. The information gained is outlined below.

Method of rearing B. froggatti.

In studying the life-history of the beetle, eggs were kept under observation until the larvae emerged, and these larvae were then placed in portions of freshly-cut coco-nut leaflets, which were kept in glass tubes or jars, the openings of which were closed by thin calico held in place by rubber bands. Each day, fresh portions of young leaflet were cut, and the larvae removed from the old leaflet and placed in the new. The same method was used for feeding newly-emerged adult beetles, whose longevity and oviposition habits were the subject of study. In the case of the larvae, the ends of the portion of leaflet were closed with metal clips to simplify the findings of cast skins after each ecdysis. This technique is very simple, and proved quite satisfactory.

The Egg.—The egg is light-brown in colour, dorso-ventrally flattened, rectangular in shape, with rounded ends, and about 1.2 millimetres long and 0.6 millimetres wide. The sides and upper surface have a strongly sculptured network design, the lower surface being plain, often with longitudinal furrows, and the eggs are laid between or inside the tightly-folded young leaflets, with their long axis parallel to the long axis of the leaflet. An egg-mass consists of from one to four eggs placed end to end, each egg being covered with excreta by the beetle, very lightly on the upper surface, and more densely at the ends and sides. Each egg-mass is deposited in a furrow previously chewed out of the leaf by the adult beetle.

The Larva.—The larva hatches through a longitudinal split along the side of the egg. It is at first almost white in colour, except for the more heavily chitinized parts, but later becomes light yellow. Fleshy protuberances are situated laterally on the abdominal segments, and there are spiracles on the first thoracic segment (very prominent) and on the abdominal segments. At the anal end is a strongly-chitinized plate, with a pair of strong, pincer-like processes projecting backward.

It feeds between and inside the unopened leaflets, causing browning and final death of the tissue attacked. Of the larvae kept under observation in the laboratory, eight apparently passed through from three to five instars, and one through six. Feeding ceases for a few hours before and after each ecdysis. At the end of the final instar, there is a prepupal period of about three days, during which no feeding takes place.

The Pupa.—The pupa emerges by the splitting of the prepupal skin along the dorsal portion of the thorax, and is at first white in colour, except for the cast skin, which remains attached to its anal extremity, the pincers pointing

backwards as in the larva. Later, it darkens to a yellow-brown tint. On the fifth day of the pupal period, the elytra and eyes are somewhat darkened, and on the sixth and last day, they have become quite black. On the anterior portion of the head, the pupa is finished with three curved spines.

The Adult.—The adult beetles are approximately 8 to 10 millimetres in length and 2 millimetres wide, the males being in general smaller than the females. It is difficult to distinguish between males and females without dissection, the best character being the length of a process which projects forward between the antennae. In the males, this process is more than half the length of the first antennae segment, whereas in the females it is less than half this length. The beetles are flattened with short, sturdy legs. The head and antennae are black, and there is a triangular black spot on the anterior margin of the thorax, immediately behind the head. The thorax and a band about 1 mm. wide on the anterior portion of the elytra are yellow-brown, the remainder of the elytra being black. Ventrally, the thorax is yellow-brown, and the abdomen brownish-black. The forelegs are entirely yellow-brown, and the hind legs brownish-black, while the middle pair have yellow-brown femora and brownish black tibiae and tarsi. The adults feed among the young, unopened leaflets, chewing the tissue in narrow lines parallel to the midrib of the leaflet. As they live much longer than the larvae, they probably do more damage to the infested plant.

Food Plants.—A number of palms serve as host-plants for *Brontispa froggatti*, the known ones being as follows:—

Cocos nucifera—The coco-nut palm.
Metroxylon sagu—The sago palm.
Areca catechu—The areca or betel-nut palm.
Washingtonia filigera—An ornamental palm.
Oreodoxa regia—The royal palm.
Elaeis guineensis—The oil palm.
Thrinax parviflora—An ornamental palm.

Life History.—Only nine larvae were observed from hatching to maturity, and the number of larval instars noted varied from three to six. One larva had three instars, two larvae four, five larvae five, and one larva six. It is possible that some of the cast skins were overlooked, and that the lower numbers of instars are not accurate. Data are appended, the figures being in days—

Larva.	First Instar.	Second Instar.	Third Instar.	Fourth Instar.	Fifth Instar.	Sixth Instar.	Total Larval Life.
No. 1 ..	9	14	14	..	..	..	37
No. 2 ..	8	5	5	20	..	..	38
No. 3 ..	9	6	7	14	..	..	36
No. 4 ..	8	5	5	10	9	..	37
No. 5 ..	4	5	5	6	10	..	30
No. 6 ..	4	5	6	7	11	..	33
No. 7 ..	4	6	5	7	12	..	34
No. 8 ..	4	7	4	7	18	..	40
No. 9 ..	4	5	5½	5½	7	13	40

The sex of the beetles which finally developed from larvae "1" to "4" was not observed, but larvae "5" to "9" developed into males. No careful study has been made of the sex-ratio in *Brontispa froggatti*, but general observations give the impression that there is a great preponderance of males. Copulation, which takes place at intervals throughout the adult life, occurs inside the unopened leaflets.

Incubation Period.—The incubation period of the egg is usually five days.

Pupal Period.—The pupal period is six days.

Pre-oviposition Period.—Only one lot of five newly emerged adults was kept under observation to determine the egg-laying habits of the beetle. One of these escaped before its sex was noted, so that it is not known whether the five beetles comprised one female and four males or two females and three males. The beetles emerged from pupae on 20th September, 1939, and a single egg was laid on 15th October, giving a pre-oviposition period of 23 days. Two eggs were laid on 22nd October, and from then onwards egg-masses were deposited regularly, about three times a week.

Oviposition.—As there was never more than one egg-mass laid in any one day, it is probable that only one of the beetles was a female. At the time of writing, 163 days after emergence of the beetles, there are three survivors, two males and one female. Forty-four egg-masses have been deposited, comprising 93 eggs, the number of eggs per egg-mass having varied from one to four. Thus the period of oviposition so far has been 140 days, the rate of laying having fallen off considerably during the last two months.

During the last fortnight, 15th-29th February, three egg-masses have been deposited, comprising six eggs. During a period of three weeks, 25th January-15th February, immediately preceding the last fortnight, there was no oviposition.

Number of Generations Per Year.—Forty-nine eggs had been laid by 3rd December, 1939, so if we take this as approximately the middle of the egg-laying period, we have a figure of 74 days from the first emergence of adult to the middle of the oviposition period. Hence the average length of a generation would be as follows:—

	Days.
Incubation period	5
Larval period	36
Pupal period	6
Pre-oviposition period	74
Total—Egg to egg	121

Thus there would be three generations per year. The shortest time for a generation would be as follows:—

	Days.
Incubation period	5
Larval period	30
Pupal period	6
Pre-oviposition period	23
	64

These figures apply to the Rabaul District, where the mean daily temperature is 80° F.

Parasites of *Brontispa froggatti*.—Two species of native parasites have been found in the Rabaul District, a *Trichogrammatid* egg-parasite, and a *Eulophid* parasite on the larva. The former attacks quite a large proportion of the eggs, but the latter is comparatively rare.

Tetrastichodes Brontispae, Ferr.—This Eulophid was introduced from Java to the Solomon Islands several years ago, and, by courtesy of Messrs. Lever Bros., colonies were sent from the Solomon Islands to Rabaul in August, 1939. The parasite has not so far been a success in the Solomon Islands, but, having regard to the large measure of control which it exercises on *B. froggatti* var. *selebensis*, Gestro. in the Celebes, it was considered worth a trial here. Breeding of the parasite in the laboratory has proved very simple, and considerable numbers of the wasps have been liberated in the Rabaul, Kokopo, Kavieng and Namatanai Districts. On Wangaramut Plantation, in the Rabaul District, where liberations have been most numerous, scattered pupae parasitized by *T. brontispae* have been collected, showing that the parasite has established itself on a small scale. About 100 such pupae have been found during the last three months. It has yet to be seen whether the parasite will multiply sufficiently to exert any measure of control of the pest.

Method of Bulk Breeding.—To obtain material for bulk breeding of *T. brontispae*, native workers are continually employed in collecting leaflets containing larvae and pupae. These are brought into the Territory, and all pupae four days old or less (i.e., with undarkened elytra) are picked out and used as hosts. Older pupae are too advanced in development for successful attack by the parasite. The larvae are placed in a jar containing coco-nut leaflets as food, and after two days, they are taken out of the jar, and all the pupae formed during the two days are used as hosts.

The selected pupae are placed in a glass tube, 8 inches by 1½ inches, up to 200 pupae being put in one tube. Approximately two wasps per pupa, or slightly fewer, are placed in the tube, and left for two days, after which, the pupae are removed and stored. The parasites are fed on slightly diluted honey, placed in minute droplets on a piece of leaflet. In this way a very high percentage of parasitism is obtained, and good sized wasps emerge when development is completed within the pupae. Developmental period is about eighteen days.

Mites Associated with *B. froggatti*.—Two species of mites are frequently associated with the beetles in the leaflets of infested palms. Sometimes they are found moving freely inside the leaflets, and sometimes they are attached to the body of the adult. Eggs of mites have been found in the furrows left by the feeding of the beetles. One of these mites is strongly chitinized and bright red in colour, and has been identified by Mr. H. Womersley, of the Adelaide Museum, as belonging to the genus *Anoplocelaeno*.

Bacteria.—An occasional larva of *B. froggatti* is found apparently attacked by a bacterial disease. These larvae are red or black in colour, and the body contents have degenerated into slime. One second-instar larva which was being kept under observation in the laboratory was attacked by this disease. One day it appeared perfectly healthy, and the next day it was dead, completely blackened, and with its body contents a slime.

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A SIMPLE PLANTATION LEVEL.

Many jobs on a plantation, such as the installation of a drainage system, require careful levelling. This can be done with sufficient accuracy by the planter with the aid of the simple piece of apparatus shown in Figure 1. This apparatus and the method of using it were first described by H. B. Roe, of the University of Minnesota, and can be made by any amateur carpenter.

The material required is—

A carpenter's 24-in. wooden level of good grade.

Two peep sights.

A pine table 10 inches square with tripod legs.

Several thin pine wedges.

A rod of clear white pine 1½ to 2 inches wide and 10 to 12 feet long, with feet, half-feet and quarter-feet marked on it in blue or black crayon.

Three 3-in. heavy tee hinges with screws.

Table 1 in connexion with Figure 2 will show the simple principle of levelling, but the following absolutely essential points should be kept clearly and constantly in mind:—

For each position of the levelling instrument at least two readings must be taken—a backward sight, or "backsight", on the last point read at the last preceding position of the level; and a forward sight, or "foresight", on the new and unknown point. Bear in mind that a backsight is a reading on an old point the relative elevation of which is already known, while a foresight is a reading on a new point of which it is wished to know the relative elevation. The names backsight and foresight, therefore, have nothing to do with the actual direction in which one may be looking, as, after the backsight has been read for any given position of the level, foresights may be read on any number of new points lying in any direction from the levelling instrument.

One should never try to take shots over 6 rods or 100 feet long in any direction with this type of level, and a shorter maximum distance is desirable.

If the bubble is not at centre, bring it there just before taking each reading. The wedges are for this purpose. Set the table in such a position that you do not need to use more than one wedge at a time.

The method of levelling shown in Table 1 and Figure 2 is applicable to any type of levelling instrument with which readings are obtained by sighting at a graduated rod.—R. C. H.

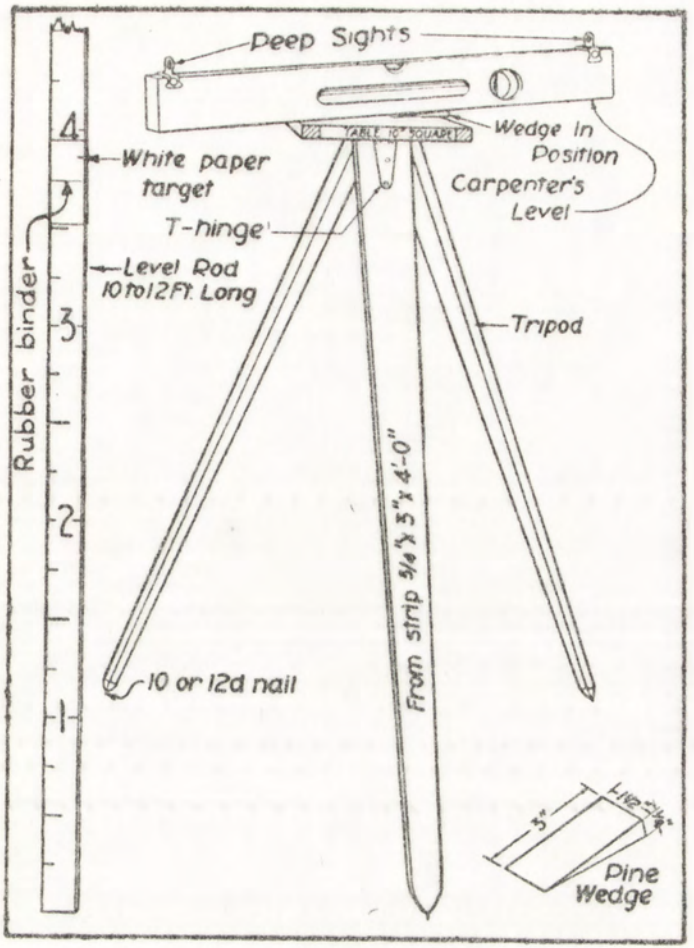


Figure 1.

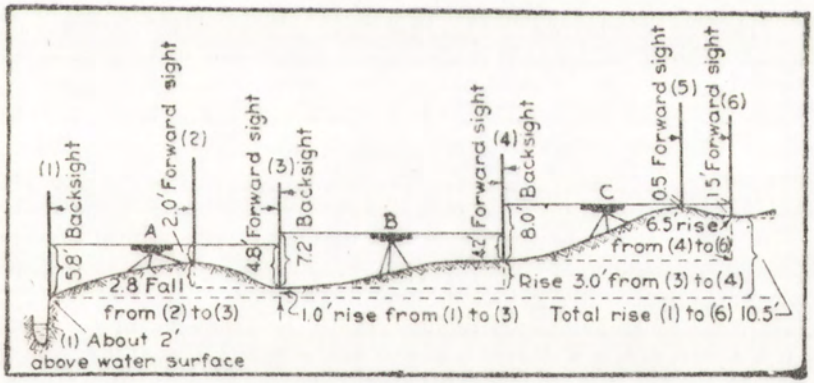


Figure 2.

TABLE 1.—SYSTEM OF LEVEL NOTES FOR DIFFERENTIAL LEVELLING.

Point No.	Position of level.	Backsight.	Foresight.	Difference of level.			Description of points.	Explanation of Computations.
				From last point.	From last Backsight.	Total from point No. 1.		
1	A	5.8					Starting point on ditch bank	
2			2.0	+3.8	+3.8	+ 3.8	Top of knoll ..	All differences = backsight on No. 1 — foresight on No. 2
3			4.8	−2.8	+1.0	+ 1.0	Bottom of pocket	First difference = difference between foresights on No. 1 and No. 2. Other differences = backsight on No. 1 — foresight on No. 3
3	B	7.2						
4			4.2	+3.0	+3.0	+ 4.0	Foot of steep slope	First two differences = backsight on No. 3 — foresight on No. 4. Total difference = 5.8 + 7.2 — 4.8 — 4.2.
4	C	8.0						
5			0.5	+7.5	+7.5	+11.5	Top of knoll ..	First two differences = backsight on No. 4 — foresight on No. 5. Total difference = 5.8 + 7.2 + 8.0 — 4.8 — 4.2 — 0.5.
6			1.5	−1.0	+6.5	+10.5	Bottom of pocket	First difference = difference between foresights on No. 5 and No. 6. Second difference = backsight on No. 4 — foresight on No. 6. Total difference = 5.8 + 7.2 + 8.0 — 4.8 — 4.2 — 1.5 = 10.5.

MANUS METEOROLOGICAL NOTES.

(B. G. Challis, Department of Agriculture.)

There is very little meteorological data available for the Manus District. This district comprises all islands and coral atolls of the Admiralty Group lying between 0° 45′ and 2° 57′ south latitude. Manus, or as it is sometimes called, Admiralty Island, is the largest island of the group. Its length from east to west is about 50 miles and it is less than 20 miles in width from north to south. Of the 800 square miles comprising the area of the whole district, Manus, or Admiralty Island, occupies 633 square miles of the group. The island is mountainous and well forested. The highest point reaches about 3,000 feet.

Apart from the Island of Manus the remainder of this district comprises scattered islands of sandy coral nature. The group of islands to the west, known as the Western Islands, are typically low-lying coral atolls which have probably developed by a gradual subsidence of the sea bottom or tectonic movement and conditions favorable for the growth of coral organisms.

These coral atolls have been mainly formed by the work of coral polyps or anemones and the assistance of the accumulated remains of shell-fish and deposits of bird manure. In some cases, drifting marine weed and vegetation has also helped when washed ashore on the windward side of the atolls by the heavy seas which are often experienced in these parts.

It is also interesting to note that the outlying islands of Manus have been subjected to huge tidal waves, due to seismic disturbances, which have swept right over the low-lying islands with devastating effect.

The only Station from which meteorological records have been supplied over a number of years is at Lorengau, the chief administrative centre in the Manus District. Lorengau, situated latitude 2° 20′ south and 147° 20′ east longitude, lies on the southern shore of Sea Eagle (Seeadler) Harbour, which is formed by Los Negros Islands and the north-east coast of Manus Island.

In view of its situation, the climate of Lorengau may be described as possessing the typically characteristic features associated with a coastal station of an equatorial island, i.e., with uniform temperatures, high humidity and copious rainfall. In this district the air flows practically uninterruptedly over the low-lying islands, coral atolls and warm tropical seas. It becomes heavily charged and saturated with moisture, with the consequence that weather conditions are generally oppressive, the only distinguishing seasonal variation being marked by the direction and force of the prevailing winds, which are usually referred to as the north-west monsoon and south-east trade winds. There are, of course, slight diurnal changes in barometric pressures, humidity, cloudiness, rainfall and wind.

The north-west monsoonal period commences slightly earlier in the Manus District than in the more southern districts of New Guinea. It generally lasts from November to March, when a change occurs by the appearance of the south-east trade wind which prevails from about May to October.

It may be noted that there are two shorter seasons of calms or feeble winds which are associated with thunderstorms and variable weather known as "inter-monsoon" and "inter-trade", which mark the change-over from the monsoon to the trade winds during October to November and between April and May.

The prevalence of the north-west monsoon corresponds with the winter of the northern hemisphere. Actually the monsoon wind is a continuation of the north-east trade wind originating in about 30° North of the Pacific Ocean, but whose course is deflected by the optimum rotation of the earth's axis at the equator, with the result that around the Admiralty Group the winds prevail more from the west or north-westerly direction. It is interesting to note that during the so-called south-east season the prevailing winds blow more from the east than true south-east.

Slight land and sea breezes may be felt around the coast of the main island of Manus, where they tend to blow off shore at nights from about 11 p.m., and on shore from about 9 a.m. The usual lull at sundown is experienced if the monsoon or trade winds are not blowing strong enough to overcome these local winds, of which the on shore or sea breeze is the stronger.

An examination of the rainfall tables will reveal that there is no definite wet or dry season. Precipitation occurs evenly throughout the calendar year. Generally it may be assumed that the average rainfall throughout the district would be between 100 and 150 inches. The average annual rainfall at Lorengau for the past 23 years is 142.87 inches.

The extreme temperature range registered at Lorengau is 96° F. to 66° F., while the average maximum daily temperature is 88.8° F., with an average minimum of 72.3° F., resulting in a mean daily temperature of 81.1° F.

The average relative humidity figures for 9 a.m., 3 p.m. and 9 p.m. readings are 87 per cent., 72 per cent. and 91 per cent. respectively.

More detailed climatological data is set out in the following tables:—

MONTHLY AND YEARLY TOTALS AT MANUS DISTRICT.

(In Points), Station—Lorengau.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly Total.
1917..	872	24	638	1,342	676	503	708	877	424	1,305	1,490	368	9,227
1918..	761	2,076	1,200	1,321	1,403	2,030	2,445	1,755	1,135	1,137	993	551	16,807
1919..	771	1,204	1,168	2,225	876	1,684	1,303	151	128	1,480	1,688	1,397	14,075
1920..	1,283	892	786	1,832	959	1,347	1,793	1,402	869	1,136	967	2,656	15,922
1921..	1,394	398	697	1,545	718	656	925	1,234	1,104	979	1,796	1,689	13,135
1922..	1,140	933	1,257	1,349	967	1,146	2,220	1,551	1,317	1,146	1,511	851	15,388
1923..	1,359	451	1,048	851	1,223	2,038	1,815	1,890	1,192	1,009	810	597	14,283
1924..	945	1,578	1,051	553	373	848	1,173	453	512	299	293	1,254	9,332
1925..	459	1,217	895	1,031	478	810	1,332	958	1,299	381	787	243	9,890
1926..	2,000	68	602	776	527	687	1,609	2,335	490	490	1,010	1,001	11,595
1927..	1,451	1,149	1,468	1,190	730	1,219	*	*	*	*	*	*	..
1928..	*	*	*	*	*	*	1,709	1,201	1,114	2,156	433	748	..
1929..	1,105	613	812	1,087	1,106	1,301	3,346	2,175	825	1,112	1,726	1,630	16,838
1930..	1,530	1,390	1,725	1,740	862	1,542	1,177	1,351	1,463	1,153	920	1,403	16,256
1931..	1,403	1,287	1,670	965	1,501	1,184	1,570	1,955	939	1,669	1,090	1,106	16,339
1932..	1,301	1,847	1,188	1,585	1,115	2,097	1,905	1,495	1,872	1,454	1,151	1,701	18,711
1933..	1,237	2,390	1,347	1,658	1,017	814	671	731	745	366	1,174	515	12,665
1934..	714	378	643	1,830	991	958	1,497	2,150	1,909	1,370	847	2,221	15,508
1935..	1,123	922	1,694	1,290	1,392	1,568	1,869	758	596	*	412	651	12,275
1936..	1,216	1,727	1,671	345	1,339	572	1,231	2,647	978	1,663	1,905	800	16,094
1937..	1,448	512	945	983	836	527	2,417	3,061	819	898	451	1,422	14,319
1938..	2,360	753	912	1,268	650	1,050	1,430	761	589	229	1,158	1,761	12,921
1939..	1,573	2,454	1,917	1,547	1,163	1,435	1,479	1,860	1,998	1,476	931	610	18,443
Average ..	12.47	11.03	11.52	12.87	9.50	11.83	16.19	14.89	10.14	10.91	10.70	11.44	142.87

* Not recorded.

CLIMATOLOGICAL DATA.—TEMPERATURE.

(Station, Lorengau.—Latitude 2° 2′ S., Longitude 147° 19′ E.; North Coast, Manus.—Height above Mean Sea Level, 10 Feet.)

Month—1939.	Mean.		Monthly Average 1939.	Highest Maximum.	Date.	Lowest Minimum.	Date.	Amount of Clouds Means of 9 a.m. and 3 p.m.	Days Without Rain.
	Maximum.	Minimum.							
January	87.1	72.6	79.8	91.5	10th	70.0	19th	5.9	9
February	86.5	72.7	79.6	91.0	7th	70.5	25th	6.5	8
March	86.4	72.8	79.6	90.0	13th	71.0	8th	6.3	11
April	88.0	72.1	80.0	92.0	10th	70.0	2nd	6.3	11
May	87.9	71.8	79.8	92.0	12th and 13th	71.0	24th	6.4	10
June	87.4	71.6	79.5	92.0	6th and 7th	70.5	13th	5.5	9
July	86.5	71.9	79.2	91.0	19th and 31st	68.5	9th and 24th	5.9	11
August	86.7	73.4	80.0	93.5	3rd	71.0	27th	6.4	13
September ..	87.3	72.9	80.1	90.5	25th	71.0	13th	5.8	15
October	88.1	73.4	80.7	91.5	19th	71.0	1st	6.6	15
November	87.2	73.4	80.3	93.0	13th	72.0	5th and 13th	6.2	12
December ..	87.5	74.1	80.8	91.0	6th	73.0	31st	6.1	18
Average ..	87.2	72.7	79.9	..	..	..	..	6.2	11.8
Extremes ..	88.1 October	71.6 June	80.8 December	93.5 3rd August		68.5 9th and 24th July		6.6 October	18 December

CLIMATOLOGICAL DATA.—HUMIDITY AND RAINFALL.

(Station, Lorengau.—Latitude 2 ° 2′ S., Longitude 147° 19′ E.; North Coast, Manus.—Height above Mean Sea Level, 10 Feet.)

Month, 1939.	Humidity.			Rainfall Monthly 1939.	Average Rainfall Since 1917.	Greatest Monthly Rainfall.	Year.	Least Monthly Rainfall.	Year.	Wet Days Monthly 1939.	Wet Days Average Since 1917.	Greatest fall in 24 hours.	
	Mean 9 a.m.	Mean 3 p.m.	Mean Monthly.									1939.	Date.
January ..	95	91.0	93.0	15.73	12.47	23.60	1938	4.59	1925	22.0	18.4	2.24	2.1.39
February ..	91	79.0	85.0	24.54	11.03	24.54	1939	0.24	1917	20.0	14.8	6.05	10.2.39
March	87	79.0	83.0	19.17	11.52	19.17	1939	6.02	1926	20.0	18.1	4.55	18.3.39
April	87	76.0	81.5	15.47	12.87	22.25	1919	3.45	1936	19.0	18.1	3.72	26.4.39
May	91	79.0	85.0	11.63	9.50	15.01	1931	3.73	1924	21.0	18.7	1.61	23.5.39
June	91	72.0	81.5	14.35	11.83	20.97	1932	5.03	1917	21.0	15.5	2.48	29.6.39
July	95	72.0	83.5	14.79	16.19	33.46	1929	6.71	1933	20.0	20.1	2.67	23.7.39
August ..	91	76.0	83.5	18.60	14.89	30.61	1937	1.51	1919	18.0	14.2	3.90	22.8.39
September ..	91	79.0	85.0	19.98	10.14	19.98	1939	1.28	1919	15.0	16.5	4.21	16.9.39
October ..	91	72.0	81.5	14.76	10.91	21.56	1928	2.29	1938	16.0	15.0	3.97	21.10.39
November ..	91	79.0	85.0	9.31	10.70	19.05	1936	2.93	1924	18.0	17.0	1.44	29.11.39
December ..	91	91.0	91.0	6.10	11.44	26.56	1920	2.43	1925	13.0	17.8	2.58	1.12.39
Average ..	91	78.7	84.9	15.37	11.96	..	..	..	..	18.6	17.0	3.28	..
Extremes ..	95 January, July	72.0 June, July, October	93.0 January	24.54 February, 6.10 December	16.19 July, 9.30 May	33.46 July	1929	0.24 February	1917	22.0 January	20.1 July	6.05	10.2.39

METEOROLOGICAL RECORDS.

Maty Island (Manus District).

(Wuvulu) 1° 42′ S., 142° 50′ E.

Month.	1934.		Rainfall Average, Nine Years.	Wet Day Average, Nine Years.
	Rainfall.	Wet Days.		
January	5.66	16	10.61	20.3
February	8.12	15	9.40	15.4
March	10.72	14	11.16	16.0
April	10.61	17	12.73	18.9
May	7.88	20	13.46	17.4
June	7.65	21	11.83	18.6
July	12.56	19	16.29	20.1
August	28.60	22	16.02	20.5
September	24.29	17	12.65	17.0
October	9.15	15	10.34	14.9
November	12.42	11	12.30	15.3
December	25.71	25	13.20	18.2

Rainfall for 1934—163.37 inches. Average annual rainfall for nine years, 1926–1934—149.99 inches.

Mokareng (Manus District).

2° 2′ S., 147° 27′ E.

Month.	1938.		Rainfall Average, Three Years.	Wet Day Average, Three Years.
	Rainfall.	Wet Days.		
January	19.38	20	15.73	17.0
February	8.98	18	6.02	14.5
March	8.39	22	12.57	22.0
April	10.43	15	8.42	14.0
May	..	..	5.19	15.0
June	12.73	17	7.03	15.3
July	13.30	21	12.97	20.3
August	4.30	16	12.94	20.7
September	4.51	11	8.32	13.3
October	1.85	9	9.01	15.3
November	5.22	12	23.57	14.3
December	..	..	13.04	15.0

Rainfall for 1938—89.09 inches. Average annual rainfall for three years, 1936–1938—134.81 inches.

Pelleluhn Island (Manus District).

1° 8′ S., 144° 25′ E.

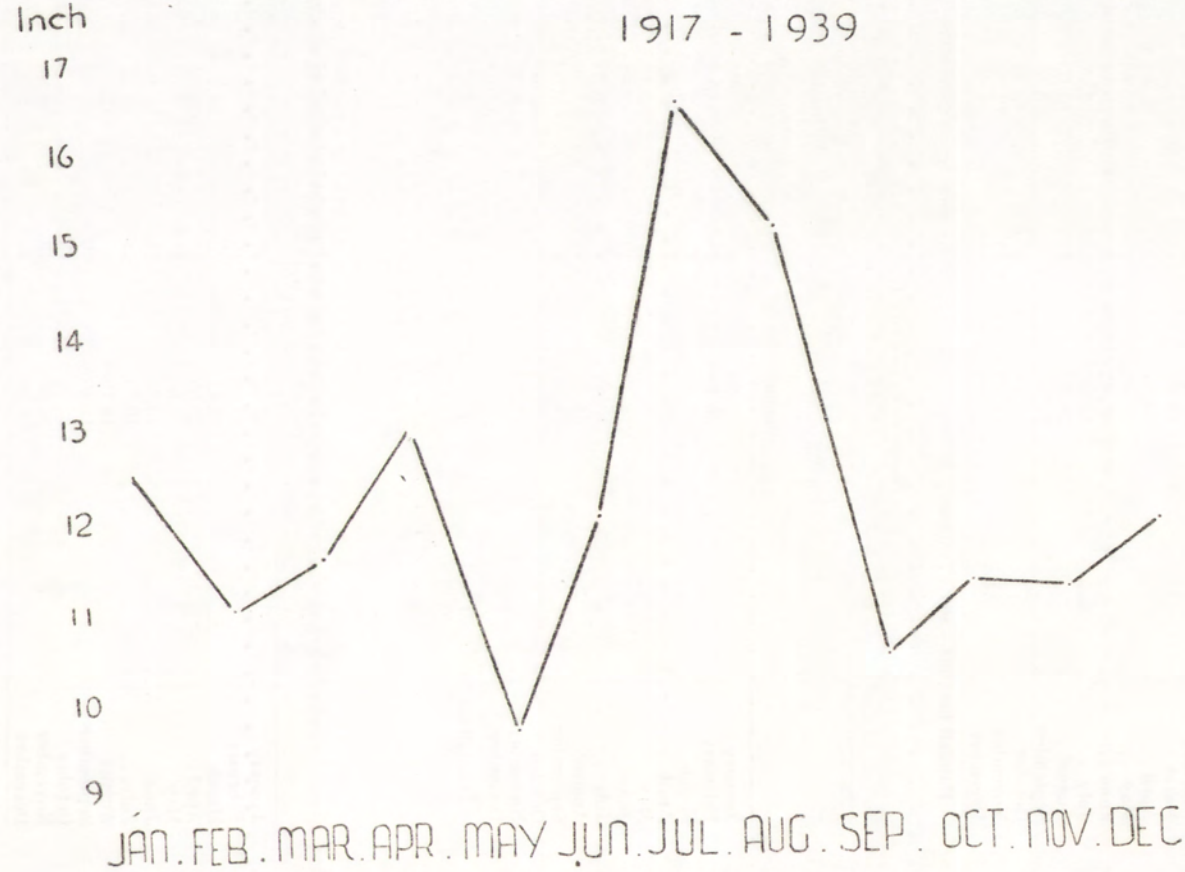
Month.	1939.		Rainfall Average, Ten Years.	Wet Day Average, Ten Years.
	Rainfall.	Wet Days.		
January	17.77	17	9.93	15.3
February	18.59	19	7.93	12.7
March	18.17	20	10.21	13.3
April	16.00	18	10.21	13.5
May	8.60	17	9.04	14.4
June	15.75	19	10.09	13.6
July	10.60	18	11.67	15.4
August	18.70	15	13.81	16.6
September	12.40	16	10.52	13.2
October	22.00	18	8.84	12.2
November	16.30	16	10.43	14.0
December	8.90	16	12.71	15.8

Rainfall for 1939—183.78 inches. Average annual rainfall for ten years, 1930–39—125.39 inches.

LORENGAU – MANUS DISTRICT

GRAPH SHOWING MONTHLY AVERAGES RAINFALL ——

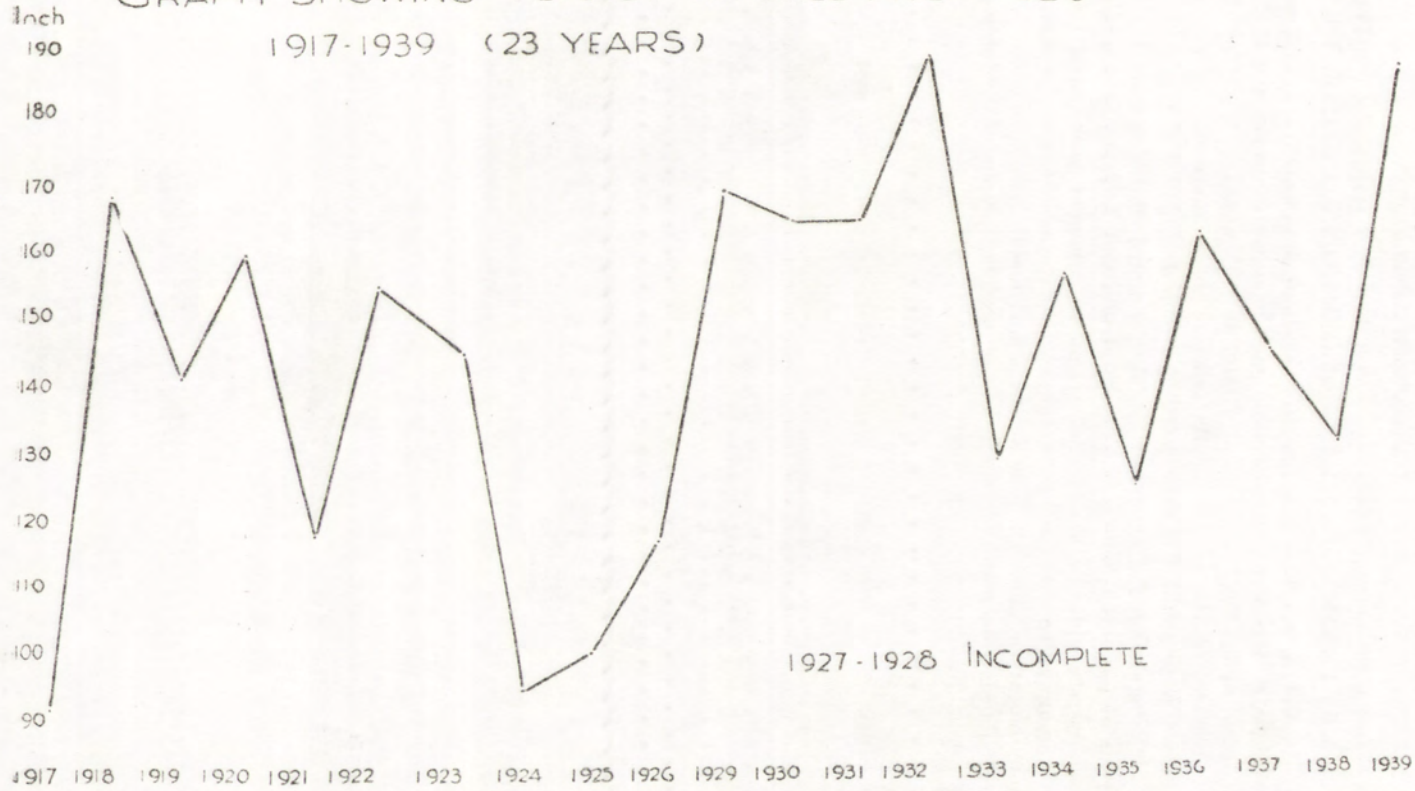
1917 - 1939



LORENGAU – MANUS DISTRICT

GRAPH SHOWING YEARLY RAINFALL AVERAGES

1917-1939 (23 YEARS)



BOTANICAL NOTES.

BANANA MUTATION.—A SECTORIAL CHIMERA CAUSED BY MUTATION (IN THIS CASE LOSS) IN A COLOUR FACTOR.

A very interesting specimen of bananas was sent to this department by Mr. F. B. S. Hislop from the Bulolo gold-fields, on the mainland of New Guinea. The hand of bananas consisted of a total of 92 bananas in seven bunches attached to the nodes of the rachis (fruit stalk). The bananas on the proximal bunch, however, were small and only partly developed.

The striking characteristic which prompted the sender to observe this particular hand of bananas was that the fruits and, in fact, the whole of one main shoot, were divided into two almost equal component areas, half being red and half being green. This parti-coloured effect was obviously a somatic (body) colour mutation, known to geneticists as a chimera.

This phenomenon is depicted in photographs 1, 2 and 3, which well illustrate the colour differences from different aspects.

Figure 1.

Figure 2.

Figure 3.

The original banana sucker from which the chimera developed was originally cut from a whole-coloured, red banana-stool. It was planted at Baiune Station, 2 miles from Bulwat, Bulolo, at an elevation of 1,900 feet, and the age of the plant from which the banana was received was about two years and three months.

The true identity of the variety of bananas is not known for certain, but it was believed to be a Cavendish type, judging from the size of the banana and the yellowish flesh when ripe.

According to the original sender the colour division (chimeric condition) existed right from the base to the top of the main shoot bearing the hand of bananas, being divided into two component areas, half red and half green, and both the stalk and the leaves (also probably the flowers) showed this distinct division into two practically equally divided areas. This colour variation also continued from the main corm right through the stalk of the rachis (fruitstalk) (*see* photograph No. 1 showing colour division at base of rachis).

A more striking differentiation was that some of the single bananas borne on the nodes at the actual point of colour division were parti-coloured (*see* photograph No. 2). Later inquires showed that the main stool was still in existence but the new shoots did not display the chimeric condition again. A sucker obtained from approximately the area where the division occurred also had a decided tendency to throw to the red factor.

All of the bananas were examined for seed content but were seedless (parthenocarpic) so separate perpetuation by seed of the green and red sides of the one bunch was not possible. Nevertheless, as bananas are grown from corms or suckers, it was quite possible for this chimera to increase vegetatively.

Counts were made of the number of red, green and parti-coloured fruits present, with the following results:—

Red bunches, 3½ (1 small proximal);

Green bunches, 3½.

One green bunch contained one red banana. Another green bunch contained one red and one parti-coloured banana (one-quarter green banana, the rest being red).

One red bunch had one parti-coloured banana, but no whole coloured green bananas were seen on the red bunches.

The bunch marked as one-half red and one-half green also comprised one-half red and one-half green parti-coloured banana.

SUMMARIZED COUNTS.

Bunches.	Bananas.	Ratio.
3 red	54 reds	18.3
2 green	34 greens	11.3
1 half-coloured	3 parti-coloured red-greens	1

It will be seen that there has been a loss of a red colour factor involved, hence, from the banana breeders' point of view, the red colouration in bananas is dominant to green and this change to green is a recessive mutation. The green coloured bananas could be expected to breed true in hybridization work, while the red colouration would be the segregating factor.

It is doubtful whether the ratios shown have much genetical significance, as the numbers of bananas showing the different colourations were largely influenced by the position of the bunch on the fruit stalk. There were more bunches on the red side of the shoot than on the green side and where the sectional chimera passed

through one bunch, it was practically cut in halves as far as colour was concerned. It is largely from analogy and other reasoning, which indicates that a single mendelian factor is involved.

This colour variation undoubtedly originated in a single terminal growth or body cell of the original sucker during the course of cell division (i.e., in the meristematic tissue). This cell division was aberrant or irregular so that the colour passed through the chromosomes to the nucleus of one-half of the divided cell, but not to the other side. Thus, in all of those cells derived from the original coloured half of the terminal body cells, a red colouration was perpetuated, while all those cells derived from the half which lost this colouration remained green. From the layman's point of view, an occurrence of this nature gives a good demonstration of one means by which new varieties of bananas may originate in nature, without actual cross-pollination. There is no need to explain this type of occurrence to the botanist or geneticist, as loss of colour factors are the most common natural chimeras found in nature. They occur very frequently in citrus fruits (especially in the orange and lemon), also in fruit such as apples, pears, grapes, olives, and flowers such as gladiolus, poppies, sunflowers, dahlias and many other types of plants.

In a great many of these colour chimeras or variations, it is possible to trace it through the fruit, down the branch and the stem to a point where it has apparently originated in a single cell, such as in the case just described. Nevertheless, there are few chimeras described which are more striking than the one featured here.

Occurrences such as that described have turned the attention of investigators to the fundamental causes of these seemingly inexplicable phenomena, because they are so important in the study of variation and heredity.

This brings one to the study of growth substances or hormones (e.g., wound stimuli), radiation and internal nutrition, subjects which are too complex for the purposes of this article. It might be pointed out, however, that actual mechanical wounding of the terminal cells by cutting back, insect injury, &c., may lead to the release of certain wound stimuli (chemical growth substances) which may cause irregular cell division and sports to develop. It has also been stated that excessive exposure and radiation at the growing point may have a similar effect such as at high levels.

The fact that distribution of the colouration on the bananas corresponded with that on the vegetative tissue shows the essential body cell (vegetative) derivation of the fruiting tissue and also the intimate connexion beween the conditions governing growth and fruiting.

The importance of studying individual buds and cells (i.e., cytology) by plant physiologists and geneticists is also clearly indicated. The practical utility is hard to define without reference to the whole subject of growth substances and heredity studies. Even now it is possible to produce certain useful mutations artificially by the use of X-rays and in some plants, like the tomato, by continuously cutting them back until sprouting shoots occur so that new varieties originate.

In conclusion, it is explained that the main objective of this description of what may be considered by planters as a relatively freak occurrence is to show that studies of specimens such as those sent in may have real practical importance. There is also on hand a rare specimen of flowering aberration in a coco-nut which it is hoped to describe later on, so that its importance can be indicated.

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NOTICE.

DEPARTMENT OF AGRICULTURE, NEW GUINEA.

Government Demonstration Plantation, Keravat.

The Director invites those interested in agriculture to visit the Demonstration Plantation at Keravat where experiments are in progress on a number of crops including cocoa, coco-nuts and native foods.

The Plantation is situated about 25 miles by road from Rabaul where cars are available for hire at any time. Departmental cars are also frequently going to and from Keravat.

Botanic Gardens, Rabaul.

In the Economic Section of the Botanic Gardens, adjoining the Department of Agriculture, smaller experiments are being conducted on many crops, including rubber. These experiments may be viewed at any time.