ECONOMIC ENTOMOLOGY IN PAPUA AND NEW GUINEA 1948-1954

G. S. Dun, B.Sc. (Agr.) *

IT has been estimated that 10 per cent. of the World's agricultural potential is lost annually by the ravages of pests and diseases. Whilst the Territory of Papua and New Guinea is relatively free from many important pests and diseases, losses from these causes are still considerable, both in the field and in stored agricultural produce. A review is given here of the investigations in pest control carried out in this Territory by the Department of Agriculture, Stock and Fisheries in the postwar period, together with an indication of some of the more serious problems yet to be solved.

The main export crops of the Territory at present are coconuts, rubber and cacao. Rubber can be discounted in this summary as it appears to be singularly free from pest attack. The coconut is currently by far the most important crop and is affected by a number of pests, several of which are capable of causing severe damage. Cacao, on the other hand, is a crop relatively new to the Territory but, due to the influence of extremely high postwar prices, it is being expanded rapidly. It is affected by a large number of insect species and this list is continually being added to as indigenous species adopt it as a host plant in the newly planted areas. Brief notes on the work that has been done on the various entomological problems are appended below :—

(A) Agricultural Crops.—

1.—*Coconuts.*

The principal pests at present are the Rhinoceros Beetle (*Oryctes rhinoceros L.*), the Coconut Grasshopper (*Sexava* and *Segestes* spp.) and the Coconut Leafminer (*Promecotheca papuana* Cski.). Localized losses are also caused by *Brontispa longissima* Sharp., *Axiagastus campbelli* Dist., *Rhyncophorus* spp. *Tirathaba rufivena* Meyr., *Parasa lepida* Cram. and various other species of lesser importance.

(*a*) *Oryctes rhinoceros* is, as yet, of limited distribution in the Bismarck Archipelago and its confinement to its present distribution is a matter for considerable concern. The insect appears to have been introduced to the Territory during the Japanese occupation and is now well established on the Gazelle Peninsula of New Britain and, to a lesser extent, in parts of New Ireland. The damage is caused by the adults which eat their way into the crown of the palm and chew the unopened fronds which, when unfolded, results in a loss in leaf area; when this is extensive the palms may be killed either directly or by the entry of secondary organisms. The larva lives as a normal White Grub in any location providing an adequate supply of organic matter in a sufficiently decomposed state. Control of the larvæ by biological means is a difficult matter as it is not known to support any specific parasites. Two Scoliid parasites of related species of *Oryctes* were collected by the writer in Zanzibar (*S. ruficornis*) and Mauritius (*S. oryctophaga*) and these have been liberated in areas of high *Oryctes* incidence in New Britain. These liberations were effected towards the end of 1952 and in mid 1953, a further shipment of *S. oryctophaga* comprising about 1,000 gravid females was obtained from the Mauritius Department of Agriculture and released in a strong condition.

The general consensus of opinion is that complementary action by parasites and predators will be required to effect any appreciable lessening of the damage. Accordingly, stocks of the predatory Histerid, *Platylister chinensis* have been obtained from Fiji and liberated in infested areas where cattle are grazed. More recently, several species of *Leionota*, also a predatory Histerid found in rotting coconut trunks, have been obtained from Trinidad and several species of a predatory Elaterid

* Senior Entomologist, Department of Agriculture, Stock and Fisheries.

Fig. 1.
Typical coconut frond damage caused by "Oryctes rhinoceros" L.
(Photo J. H. Ardley)

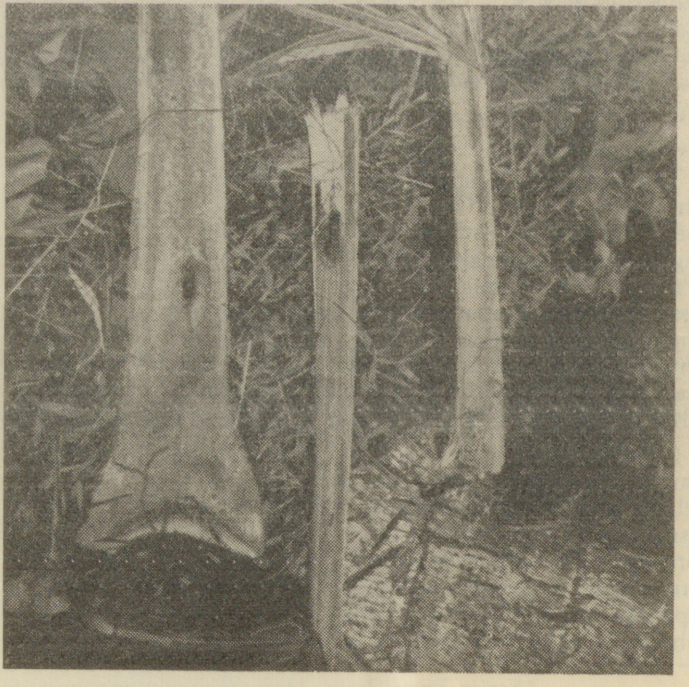

Fig. 2.
Tunnels in coconut leaf bases caused by "O. rhinoceros".
(Photo J. H. Ardley)

(*Pyrophorus*), found in similar locations are being obtained from the same source. Some general work has also been done with a local species of Dynastid (*Oryctoderus coronatus* Bates) which has the unusual habit of being predatory in the adult stage. A limited number of observations has also been made on a local species of Scoliid (*S. pulchripennis* Cameron) which is parasitic on the New Guinea Rhinoceros Beetle, *Scapanes grossepunctatus*, Sternb. The latter species incidentally is capable of causing considerable localized damage to coconuts until they reach the age of bearing. It is replaced on the Mainland of New Guinea by *S. australis* Boisd.

Control of the Rhinoceros Beetle from the chemical or general plantation sanitation angle presents considerable difficulties under post-war conditions for reasons associated with such factors as cost and scarcity of Native labour, rough terrain, heavy war damage and so on. Some experiments on trapping under strips of dead coconut trunks appear to be both uneconomic and not especially fruitful of results. Preliminary investigations of treatment of compost pits with persistent insecticides, especially gammexane, indicate that a dosage of 2 ounces per 10 cubic feet of 6.5 per cent. G.I. content will cause a reduction of up to 90 per cent. in the larval population, compared with the controls, after almost six months. These trials have recently been extended to include the use of Aldrin and Dieldrin dusts using rotted sawdust and coconut meal as the compost materials.

Hand-dusting of young Oil Palms (the only species of host readily available) with about 3 oz. of a 2½ per cent. D.D.T. Dispersible Powder in Pyrophyllite per palm has been tried to see whether it is economically possible to obviate, in bad *Oryctes* areas, the two-three years lag in coming into bearing of young palms suffering heavy frond damage. Beetles were extracted from feeding channels in the crowns of the palms for eight months after the dust was applied. At the six-monthly examination 65 per cent. of the beetles died within 48 hours. All showed obvious D.D.T. effects for this period, but the remainder recovered and most were still alive and active a month later. It is possible that the survivors had not been feeding in the crowns sufficiently long to absorb a lethal dosage. Possibly due to rather heavy rain, the seven-month count was negative, although the females, in common with the females from all the previous monthly observations, showed an extreme reduction in the number of eggs laid, a fact which was not evident with random-trapped beetles caught at the same time. These trials are being restarted on Coconut Palms with the addition of Gammexane, Aldrin and Dieldrin dusts to the treatments.

(*b*) *The Coconut Grasshopper.* Various species of Tettigoniids are the cause of severe defoliation and subsequent loss of yield in a number of localities in the Bismarck Archipelago. Probably about six species are involved, although the main ones are *Sexava nubila* and *S. nova-guineae.*

Some inquiries have been made into the possibilities of controlling the insects by aerial spraying but this does not appear to be practical under the conditions which obtain in the Territory. Similarly, power dusting, or spraying, from the ground proved difficult to carry out due to roughness of terrain, the isolated nature of many of the affected plantations and the difficulties of obtaining suitable machinery which will operate effectively under tropical conditions. There is some indication that soil treatment against the hoppers emerging from eggs, most of which are laid in the soil, is partially effective, but this is largely offset by the fact that *Sexava* is usually most harmful in areas where the rainfall is rather heavy. Treatment of the basal portion of the trunk also holds promise, since not only the emerging hoppers, but also the adult females have to return on foot to the crown after oviposition as they can only fly downwards or across from one palm to a contiguous one.

On the biological side, most work has been done to date with the Encyrtid (*Leefmansia bicolor* Waterst.) a parasite introduced to New Guinea in 1933 from Amboina. Prior to the war, it was found that this parasite was not well able to maintain itself in the field although it bred very easily in captivity. Since the war, on several occasions, outbreaks of *Sexava* have been brought under control by mass liberation of this wasp in New Britain and New Ireland and stocks are usually kept on hand in case they are required for sudden outbreaks.

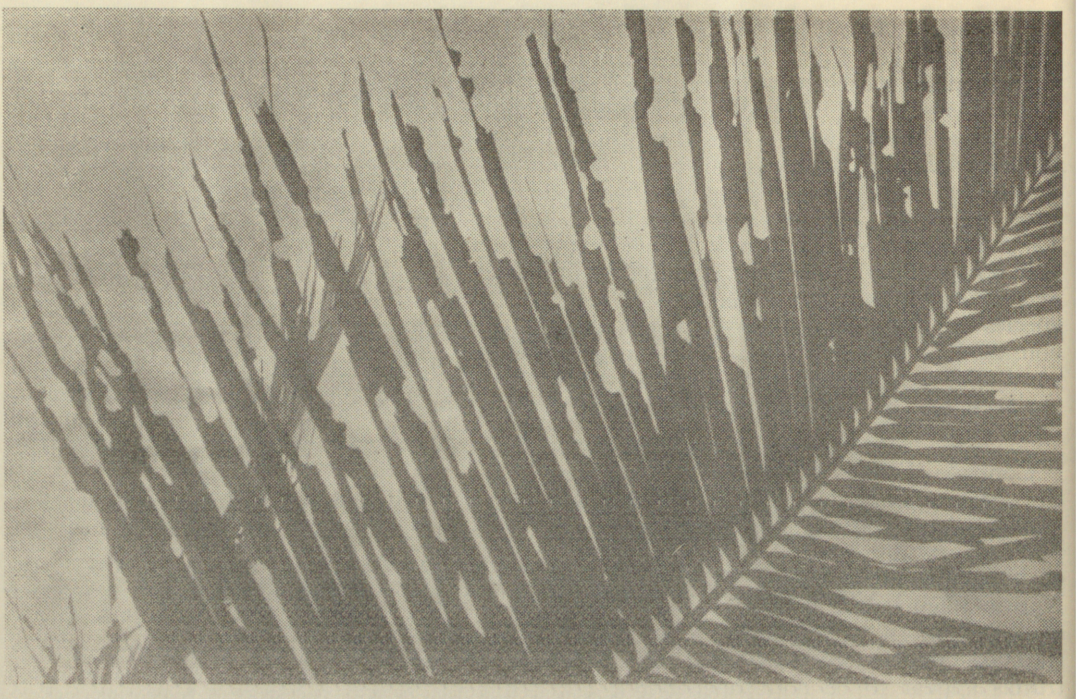

Fig. 3.
Coconut frond damage caused by "Sexava" sp.
(Photo by J. J. H. Szent-Ivany.)

During recent months attempts have been made to establish in the Rabaul District, the *Strepsipterema* parasite of the mainland species of *Sexava, Stichotrema dellaterreanum* Hof. It will attack the local species, *Sexava nubila* Stol., but work with this project is hampered by the fact that the Strepsipteron is known only from the female and it would appear that the latter requires to be fertilized. Light-trapping on the mainland has revealed the presence of the hypothetical male of the species, a Myrmecolacid, but the matter of determining its host species is likely to be an extremely difficult one.

(*c*) *Coconut Leafminer* (*Promecotheca papuana* Cski.). There has been little occasion to deal with this beetle until recent months. It is normally only a minor pest kept under control by its indigenous parasites but, due to the action of the cosmopolitan Harvest Mite, *Pediculoides ventricosus,* in preventing the parasites from functioning effectively, the miner became a serious pest in parts of Fiji and New Britain prior to the war. In Fiji the position was permanently rectified by the introduction of the wasp *Pleurotropis parvulus* in 1933. In New Guinea, the only areas where the Hispid has been serious are at the western end of New Britain at several points on the north and south coast in areas of extremely heavy rainfall. *Pleurotropis* was introduced to New Britain from Fiji in 1937, principally to overcome a one-stage outbreak at Rabaul occasioned presumably by the extremely heavy ash deposit following the volcanic eruption in 1936 which must have sufficed to allow a one-stage condition to develop.

In the Rabaul area the introduction of *Pleurotropis* appears to have permanently reduced the host to an insignificant level. However, at Linga Linga on the north coast of New Britain, the parasite has never been entirely effective and several restricted one-stage outbreaks have occurred since its introduction. At Lindenhafen, on the south coast, it has been entirely effective until late in 1953 and now (early 1954), in the two localities, some four thousand acres are seriously affected resulting in a current loss of production of some 30 per cent. at Linga

Linga and 50 per cent. at Lindenhafen, which latter figure may rise to 75 per cent. or more within the next few months.

The danger of this breakdown, of course, is that plantations and Native groves in the area are well separated and there is a distinct possibility that *Promecotheca* may have been wiped out in many of them and they may thus be subject to the risk of re-infection by coastal shipping from the outbreak areas. This condition is known to occur on one island plantation several hours' sailing to the west of Lindenhafen. To this end stocks of *Pleurotropis* are being built up in the laboratory to have available for immediate distribution in case of such an eventuality.

2.—*Cacao.*

This crop is affected by an increasingly wide range of insect pests, the eventual status of many of which, as mentioned before, it is not possible to predict. The two types of insects on which most work has been carried out are the Stem Borers and the Capsids.

(*a*) *The Stem Borers* comprise the Weevil Borer, *Pantorhytes plutus* Obert., and the Longicorn Borer, *Glenea aluensis* Gah. Both these genera are well represented in the Territory by a number of species and, no doubt, other species will attack Cacao as it becomes more firmly established and widespread. Already two other species of *Pantorhytes* have been associated with Cacao on the mainland of New Guinea.

Detailed studies of the bionomics of both species have been carried out, the work having been initiated by Mr. B. A. O'Connor, now Government Entomologist, Fiji, and completed by the writer. The Weevil Borer is the more serious of the two species, but, due to the fact that it is apterous and is not provided with an ovipositor, it is not likely to become serious until the current young plantings mature. For this reason work on the control of this species can safely be deferred until a later date although the characteristic of smooth bark has been incorporated into the cacao breeding and selection programme.

Investigations of an indigenous Dryinid parasite of both borers indicate that there is little hope that it can be used successfully against them.

Hand-collecting of the adults of *P. plutus* may eventually be of some help as they feed on the young bark and leaf petioles and have a quite marked early wet season population peak. Being apterous, banding experiments using Ostico mixed with a 10 per cent. D.D.T. powder spread for a distance of some six inches along the main trunk have produced a high mortality in adult beetles obliged to walk over the bands after a lapse of almost one year. The Longicorn Borer is not amenable to such treatment as it is semi-nocturnal in habits and flies very readily.

Several other species of Lamiids also attack Cacao in New Britain but they are as yet localized in their attack. They belong to the genera *Monohammus, Dihammus* and *Batocera.*

(*b*) *Cacao Capsids.*—These comprise a group which was only recorded from Cacao in New Guinea in 1950. They have been described as belonging to two new genera and four new species, as follows :—

1. *Parabryocoropsis typicus* Ch. and Car.
2. *Parabryocoropsis cheesmanae* Ch. and Car.
3. *Parabryocoropsis duni* Ch. and Car.
4. *Pseudodoniella pacifica* Ch. and Car.

Their action is precisely similar to that of the West African Cacao Capsids although, since their attention has been paid to this crop for only such a short period, it is not possible to say how quickly and to what extent they will develop the habit of feeding on the young shoot growth. In recent months a further Capsid, *Helopeltis clavifer* Walk., has been found attacking Cacao fruit in Papua. Since the Cacao has barely reached the stage of bearing there the rapidity with which the insect has adapted itself to the plant is remarkable.

Studies of the bionomics of the principal species of Capsid, *P. typicus,* have largely been vitiated by the fact that the insect, especially in the adult stage, is extremely difficult to handle in captivity. Given even such presumably suitable conditions as caging in large gauze cages enclosing Cacao pods on the tree, it is seldom that the females survive long enough to even commence oviposition, while males are even

Fig. 4.
Dusting to control the cacao capsid "Parabryocoropsis typicus" Ch. and Car.
(Photo by J. J. H. Szent-Ivany)

more delicate. This, of course, has made it impossible to carry out insectary insecticide trials satisfactorily.

Field trials on the control of the Capsids have been of limited extent. Since there is no indication that oviposition by *P. typicus* occurs elsewhere than in fruit tissue, it has been possible to achieve good control by complete defruiting in blocks of young Cacao. However, this is only a temporary expedient and is only possible of application when the trees are just coming into bearing.

For various reasons dusting is preferred to spraying under local conditions and quite good control has been obtained using knapsack-type dusters with Gammexane containing 1.3 per cent. G.I. BHC. While the results are not fully conclusive yet, it appears that two dustings applied at a four-weekly interval prior to the onset of the wet season (i.e. between August and October) will give a reasonably good measure of control at relatively low cost. D.D.T. applied at standard strengths, either as a dust, emulsion or dispersible powder, does not appear to be as effective, while the Gold Coast practice of controlling Capsids by painting the point of ramification of the trees with a concentrated D.D.T. paint is ruled out by the different growth habit of the types of Cacao grown in the two areas and the more or less stationary habit of the local species.

(*c*) *Miscellaneous Pests.*—These are at present classified as such, not because they cannot be serious in effect, but because they are extremely localized in distribution, some even being confined to one or two plantations to date. However, the number of such insects is gradually increasing from year to year as the area under Cacao expands and ages. General observations only have been made on the bionomics and control of the principal species. These can be divided into stem borers, bark eaters and defoliating insects.

The borers comprise principally Lamiids which attack ageing or debilitated trees; the main ones being *Dihammus* and *Monohammus* spp. and *Batocera nebulosa* Bates. The Zeuzerid *Zeuzera coffeae*, also occasions some damage but in none of these cases have satisfactory and practical control

methods been evolved yet. Localized attack by the Cacao Termite, *Calotermes papuana* Desn., may occasionally be severe, but it is readily controlled by the introduction of White Arsenic powder to the galleries.

Bark-eating species are limited in number and the principal one is the Xyloryctid Moth, *Pansepta teleturga* Meyr. This insect is semi-gregarious and may occur in numbers up to as many as one hundred larvæ on a single branch which usually results in branches of three to four inches in diameter being killed. As it is so far confined to an area comprising only three plantations, limited work has been done on the bionomics and control of this species. There it good reason to believe, however, that it will be amenable to control by cultural means. Since Cacao has certain definite shade requirements, it has been noted that the moth is almost invariably worse where these requirements are inadequately met.

Foliage-eating insects are numerous and, at times, cause extensive damage. Their action is both direct and indirect, directly by defoliation and indirectly by causing excessive proliferation of the branches which produces an ill-formed tree, prone to breaking in heavy rains and difficult of access for harvesting. The principal species involved are :—

Collembola.—*Salina celebensis.*

Coleoptera.—Curculionidae. *Pantorhytes plutus, Exopthalmida glauca.*

Chrysomelidae. *Rhyparida* spp., *Monolepta semiviolcea, Microlepta* spp.

Lepidoptera. Geometridae *Ectropis bhurmitra.*

Noctuiidae. *Achaea janata.*
Prodenia litura.

Direct fruit damage is of little current importance and, while the serious Cacao Moth (*Acrocercops cramarella*) of Java has been recorded from the Territory previously, it has not been in evidence since the War. Both the Collembolon and the Lepidopterous species are readily controlled by standard D.D.T. and BHC preparations while the Weevil Borers, and especially *P. ruralis* are rather resistant to D.D.T.

3.—*Miscellaneous Crops.*

Other agricultural crops are, as yet, little cultivated in the Territory. For this reason work in this direction has largely been confined to determining the species of insects attacking the limited number of crops under cultivation. The principal crops concerned include rice, kenaf, manila hemp, cotton, peanuts, citrus, green manure and cover crops, etc.

(B) Horticultural Crops.—

(1) As with miscellaneous agricultural crops, work has largely been restricted to determining the species involved. In some instances with vegetable crops in wide use, trials with standard insecticides (D.D.T., BHC, Toxaphene, etc., and more recently Aldrin and Dieldrin) have been carried out. The pests thus experimented with include such species as Bean Fly (*Melanagromyza phaseoli* Coq.) Corn Borer (*Pyrausta damoalis*) Cutworms (*Prodenia litura* and *Spodoptera mauritia, Heliothis armigera*), etc.

(2) *Giant African Snail.* The principal work in this section comprises a rather detailed study of the life-history, ecology and some methods of control of the Giant African Snail, *Achatina fulica hamillei* Bowdish. This pest was introduced to various parts of the Territory during the Japanese occupation. There is some difference of opinion as to the true economic status of this snail, but it is probably more a horticultural than an agricultural pest and causes considerable and insidious losses in Native food gardens and European vegetable and flower gardens. There is, however, a distinct possibility that it could become of some agricultural importance in certain crops if they were grown on a sufficiently large scale. Such crops could feasibly be papaw, peanuts, citrus, castor oil, kenaf, etc.

Despite the lack of adequate quarantine facilities, the Territory has been fortunate in that, apart from one or two minor instances, the snail has not greatly increased its spread since the War. The main centres of infestation are still the original ones—Kavieng District in New Ireland, the Rabaul District in New Britain and the Hansa Bay District on the north-east mainland coast. In several instances, prompt recognition of an introduction has permitted extermination of the pest following an inadvertent introduction.

A pronounced feature of the snail's activities is its immense reproductive capacity immediately following its intro-

duction to an area. There is some indication that this initial impulse declines after some five to ten years and it is a fact that gigantism is much less frequently encountered after the first five years. Nevertheless, the snail is unlikely to decline to a completely uneconomic level in suitable environmental areas where susceptible crops are grown on a small scale.

Life-history observations on pairs and groups of individuals have been carried out over a period of two and a-half years, at which point they had to be discontinued due to lack of staff. At the same time ecological observations were carried out on such points as feeding habits, duration of aestivation, resistance to desiccation, rate of spread and many other points.

Completely effective control of the snail has not been possible to achieve although the effectiveness of natural barriers in hindering its spread has been demonstrated on many occasions. Such barriers include mountain ranges—even of limited height—kunai (*Imperata arundinacea*) flats, rivers, etc.

It is hoped at a later date that predators will be obtained. Earlier attempts by the writer to collect several predators in East Africa were negatived by the preceding lengthy dry period which had sent virtually all the snail population into aestivation at the time of the visit.

Methods of chemical control tried have relied on the attractiveness of Metaldehyde, the lethal quality of Calcium Arsenate and the repellant nature of Creosote (or Coal Tar). It has been found that a 3 per cent. dispersion of Metaldehyde in relatively old sawdust is both attractive and lethal and considerably less expensive than proprietary mixtures. It has been principally used in the Territory to protect young Cacao seedlings planted at stake as these are most susceptible to snail attack up to the time they form their first hard leaf (eight to ten weeks). This mixture has been used quite a lot to protect plots of especially susceptible plants, such as legumes, on Experiment Stations. The incorporation of Metaldehyde with cement as briquettes has also been tried but is too slow acting. Spraying with the poison dispersed in water using a detergent proved ineffective presumably because it was not possible to get a lethal dosage on to the plant.

Calcium arsenate washes applied to tree trunks, boulders, etc., were effective to a limited degree, but did not appear to stand up well to the heavy rain of the wet season when the snail is most abundant and destructive.

For the protection of limited areas of vegetable garden the most effective method was found to be to enclose the area with 6-inch planks, placed edgewise and painted with crude creosote. Even in wet weather it was found that the repellant qualities will last from three to four weeks and, while relatively inexpensive, very few snails will cross the barrier. Trials with DNOC showed that, while effective, it has not the persistent qualities of creosote.

In areas of high snail density it is still, however, necessary to regularly hand pick if the numbers are to be kept within reasonable numbers outside the specially protected areas, even if only from the sanitation viewpoint. For instance, in the writer's garden, approximately 1½ acres in extent, the daily picking, depending on the preceding day's rainfall, will vary from 500 to as many as 3,000.

One of the most effective measures, not in keeping snail numbers down but in reducing the amount of damage that is done has been found to be in utilizing a knowledge of the plants which the snails will or will not attack. By suitably disposing one's flower or vegetable garden in such a manner that the susceptible plants are the last exposed to the snails' attack, it is possible to keep the damage to a minimum. As an example the following few susceptible flowers and vegetables may be quoted :—

Flowers.

Susceptible.	*Immune.*
Zinnias	Gerberas
Marigolds	Dianthus
Liliaceae	Gladiolus

Vegetables.

Susceptible.	*Immune.*
Cruciferae	Spinach
Cucurbits	Spring Onions
Mint	Parsley
Brinjals	Beans & Tomatoes (if staked)
Carrots	
Lettuce	Corn

It is possible also on occasions to make use of catch crops. An example of such a plant is radish, which is an extremely quick grower, gives good shelter to the snail during the day and thereby attracts them away from nearby susceptible but more useful plants, especially vegetables.

Apart from Calcium arsenate, trials with standard insecticides have had negative results, as one would more or less expect. Aestivation studies have shown that in extreme cases snails are able to remain dormant for as long as twelve months and still recover. Accordingly, snails fed with plant material treated with materials repugnant to them simply withdraw into their shells, form an epiphragm and emerge at varying intervals until acceptable food is available for them. An interesting fact worth investigating is the marked non-susceptibility of tobacco to the snails.

(C) Insects of Stored Products.—

Losses in stored products in the Territory are particularly high, especially in Native imported foods such as brown rice, wheatmeal, dried peas, etc. Losses in European foodstuffs such as polished rice and flour are less but are, nevertheless, of a continually recurring nature. The high incidence of these pests is partly due to the consistently high temperatures throughout the year but appears to be largely due to the generally poor bulk storage conditions which prevail, these being still based principally on ageing War Disposals materials.

While all the cosmopolitan species appear to be present in the Territory, the bulk of the damage is done by the Grain Weevils and the Flour Moth (*Ephestia cautella* Walk.). The Bean Weevil (*Bruchus chinensis L.*) also causes much loss in dried peas used for Native rations and in legume seed generally. In the latter case good control has been obtained by dusting with minute quantities of BHC with no apparent adverse effect on viability. Limited trials with the control of *Ephestia* by the application of a concentrated Gammexane wash have been quite successful although the use of Gammexane Smoke generators, even in such buildings as Quonsett Huts, which would appear to be eminently suitable, has had little effect.

(D) Forests and Forest Products.—

Work in this field has been of an extremely limited nature as the main forestry centres are situated too far away. Some minor investigations, in connection with a nearby re-afforestation scheme, include—

(*a*) protection of seed beds from the Gaint Snail and the protection of the young seedlings from the same pest;

(*b*) control of the Teak Moth (*Hyblaea puera*) in Teak seedlings using D.D.T. and BHC preparations; and

(*c*) the use of Chlordane as a dispersible powder to control Mole Crickets [*Gryllotalpa* spp. (*G. africana?*)] in nurseries.

No opportunity has occurred to investigate the damage caused by the large Weevil Borer (*Vanapa oberhuri*) in the pine forests in the Highlands.

(E) Insects of Pasture and Field Crops.

Little occasion has arisen to investigate these types of problems to date. As mentioned above crops like corn and sorghum can still be considered as horticultural crops. Rice is cultivated on a much larger scale although still relatively small, but it does not appear to suffer greatly from the various serious Stem Borers which are present in South East Asia, the Philippines and Indonesia, although several of these are known to occur in the Territory. Perhaps the greatest spasmodic pests of this crop are the Coreids, *Leptocorisa* spp. which sometimes cause serious loss of grain. On small plots, successful control of these has been obtained with knapsack dusters using proprietary D.D.T. preparations of standard strength.

Pasture crops are at present of little importance in the Territory although a White Grub, *Lepidiota* sp., has been causing some damage to turf in the Highlands during the past few years. No opportunity has occurred to investigate this pest.

(F) Insects of Medical and Veterinary Importance.—

(1) *Medical.*

This field is at present outside the scope of the work of the writer and attention has been confined to obtaining determinations of the commoner pest species of mosquitoes, sandflies, etc.

(2) *Veterinary.*

This field is at present also outside the scope of the writer and studies have likewise been limited.

An interesting new record is the determination of the Old World Screw Worm (*Chrysomyia bezziana* Vill.) as being wide spread in the Territory and the islands. However, from verbal accounts, it appears likely that its presence is a long standing one.

While cattle have been only slowly re-established in the Territory since the War, it is interesting to note that the Buffalo Fly, although known from New Britain for at least the past thirty years, is currently of singularly little importance. On the other hand the Stable Fly is frequently quite abundant and irritating.

(G) Household Insect Pests.—

As is usual in the tropics, and especially in the Territory where the housing conditions are generally of a primitive nature, household insect pests assume a position of considerable importance. The principal types which are concerned are the Cockroaches and Ants (*Periplaneta americana* and *P. australasiae* and *Pheidole oceanica* and *Pheidole* sp.). Experimental work on these species has been confined to finding a suitable method of control in houses. Chlordane has given by far the best results to date. Dosages and treatments sufficient to cope with ants are such that Cockroaches are unlikely to be found in houses where the former insects are kept reasonably well under control. Trials with samples of Aldrin and Dieldrin have been initiated but have not yet yielded positive results. The common Silverfish does not appear to be capable of assuming a role in the Territory similar to what it can assume under more temperate climatic conditions.

(H) Biological Control.—

Opportunities for working on this subject, apart from introductions against the Rhinoceros Beetle, have been limited although it is an undoubted fact that New Guinea offers unlimited scope for work of this nature. In fact, the breeding out of larvæ of insects of minor economic importance is often seriously hindered by the presence of parasites and hyper-parasites. As an example, efforts to export to Fiji a species of *Apanteles* parasitic on a Coconut Moth *Agonoxena pyrogramma* Meyr. have been continually thwarted by the effectiveness of the control the parasite exercises.

A preliminary investigation has been carried out of the parasites affecting Sugar-Cane Borers in New Britain with a view to finding out whether any would be suitable for use in Mauritius. There appear to be two local species of Borers, a Crambid *Chilotraea terenellus*, and a Noctuid, *Sesamia grisescens*. From these five species of parasites have been reared, two Braconids, two Tachinids and an Ichneumon, most of which are not specific in their choice of hosts. A reasonable shipment of the Ichneumon, *Enicospilus* sp. has been made to Mauritius, but a smaller shipment of the larger Tachinid, *Carcelia evolans* was unsuccessful, due largely to the presence of a hyperparasite, *Exorbistobia* sp. Fam. *Encyrtidae*. While the two Apanteles are not uncommon, their shipment is rendered difficult by the fact that the pupal period is a week or less and the adults will not survive in captivity for more than twenty-four hours.

A shipment of the Tachinid, *Bactromyia frasseni*, parasitic on the Banana Scab Moth, *Nacoleia octasema* to Fiji was not successful.

(I) Insecticides.—

No facilities are available for formulating insecticides in the Territory and work on this subject has been confined to the control of individual species affecting economic plants using standard proprietary preparations, as mentioned under the various headings above. Much the same applies to the methods of application except that, under Territory conditions, it has been found that for the current major crops none of the types of power machines tried has been really satisfactory. This is largely due to the rough type of terrain over which the machines have to operate. For the control of pests in Cacao it has been found that dusting is generally preferable to spraying, a fact which is dependent upon the physique of the Native carriers, the simpler distribution problems and the fact that the normally very still air allows the dust to be satisfactorily placed in the position desired.

(J) Insects and Viruses. Insect Physiology. Population Dynamics.—

No work has been undertaken specifically on these subjects during the period under review.

(K) Taxonomy.—

The nearest approach to work on this subject has been an attempt to reconstruct the Departmental reference collection most of which was destroyed during the Japanese occupation. The shortage of staff has prevented any commencement of work on taxonomic projects. Even as far as a reference collection is concerned, progress has been confined to seeking determinations of species of some economic significance owing to difficulties of adequate storage.

(L) Quarantine.—

Little actual progress has been made in this aspect of entomological work due largely, again, to the difficulty of recruiting sufficient staff. It is, however, an extremely important problem owing to the marked discontinuous distribution of the more serious insect pests in the Territory.

As instances of the type of quarantine problems with which the Territory is confronted, the following may be quoted :—

(1) The Giant Snail is present in none of the main centres of the New Guinea Mainland or on Bougainville Island.

(2) The principal Cacao Capsids are not present in Papua.

(3) The Rhinoceros Beetle is not present on the Mainland or on Bougainville Island.

(4) The species of *Sexava* differ from one island to another : many similar examples could be added to this list.

In fact, in view of the multiplicity of shipping, both Native and European, which moves between the Mainland and the various islands, it is remarkable that no serious internal introductions have been effected in the postwar years.