The
Papua and New Guinea
Agricultural Journal

Vol. 20. DECEMBER. 1968 - MARCH. 1969 Nos. 3 and 4

CONTENTS

OBSERVATIONS ON A BORER OF COCONUT PETIOLES IN THE BRITISH SOLOMON ISLANDS PROTECTORATE

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ABSTRACT.

Larvae of an unidentified xyloryctid restricted to the islands of Choiseul and Santa Isabel damage coconuts by tunnelling into the petioles of the fronds. Coconut palms over four years of age are attacked. On young palms the eggs tend to be laid on the youngest fronds and occasionally there is no oviposition for up to two months. Biological control appears to be of little significance. Modification of secondary growth of coconut plantings is seen as a promising line of research on control which is made all the more imperative by possible future unintentional introduction of the pest to neighbouring islands.

INTRODUCTION.

Damage to coconut petioles by boring larvae on the island of Santa Isabel was first brought to the notice of the Agricultural Department in 1960. An insect pest survey begun in 1962 subsequently showed that damage also occurred on Choiseul and that the insect responsible for the damage was absent from neighbouring islands of the Solomons and the Territory of Papua and New Guinea. The damage is caused by larvae of a xyloryctid (Lepidoptera) ; adult specimens collected have not enabled the Commonwealth Institute of Entomology to place the moth in a genus.

DAMAGE.

Coconut palms under four years of age are generally not attacked. An obvious symptom of a heavy attack by petiole-boring larvae is premature senescence of leaflets of middle-aged fronds. The petioles of such fronds have numerous black necrotic spots and occasional holes particularly in the basal leafletless areas. Severely attacked petioles are tunnelled extensively by late instar larvae (*Plate* I). Recent tunnels are filled with moist brownish-black frass. The walls of the tunnels are blackened. Badly attacked fronds sometimes snap in wind.

Before premature senescence occurs, attack can be recognized by the presence of black necrotic spots on petioles and gum exudations around some of these spots. These symptoms appear on the undersides of the leafletless portions of petioles (*Plate* II).

Severe damage appears to delay fruiting of young coconut palms. Yields of older palms are probably reduced by heavy attacks of petiole-boring larvae.

In 1964, heavy attacks occurred almost all along the west coast of Choiseul. On the east coast, attacks were not as heavy and were more scattered. In the same year about 5,000 palms of all ages around Santa Isabel were checked. Of these 15 per cent. were damaged by petiole-boring larvae.

ECOLOGY.

The adult moths which are brown and about $1\frac{1}{2}$ in. long were never observed on coconut palms. The egg, oval and flattened dorso-ventrally, is about 3/16 x 2/16 in. in size. Before hatching, eggs are olive-green, empty eggs are pale brown. Eggs are laid singly or in rows in which the preceding egg is slightly overlapped by the following; up to five eggs have been recorded in a row. On five-year-old coconut palms, eggs tend to be deposited on the youngest fronds as *Table* 1 shows.

Most eggs are laid on undersides of basal leafletless areas of petioles. The maximum number of eggs recorded on a petiole was 19 on a second youngest petiole of a seven-year-old palm at Rasa, Santa Isabel.

Each larva increases in length from about $\frac{1}{4}$ in. to about $2\frac{1}{2}$ in. The last larval instar is about $\frac{1}{2}$ in. in diameter.

Monthly dissections for two years of second youngest petioles show that early larval instars are commonly found in the younger petioles and that late instars are predominant in the older petioles. These observations which are presented in *Table* 2 support data obtained in egg

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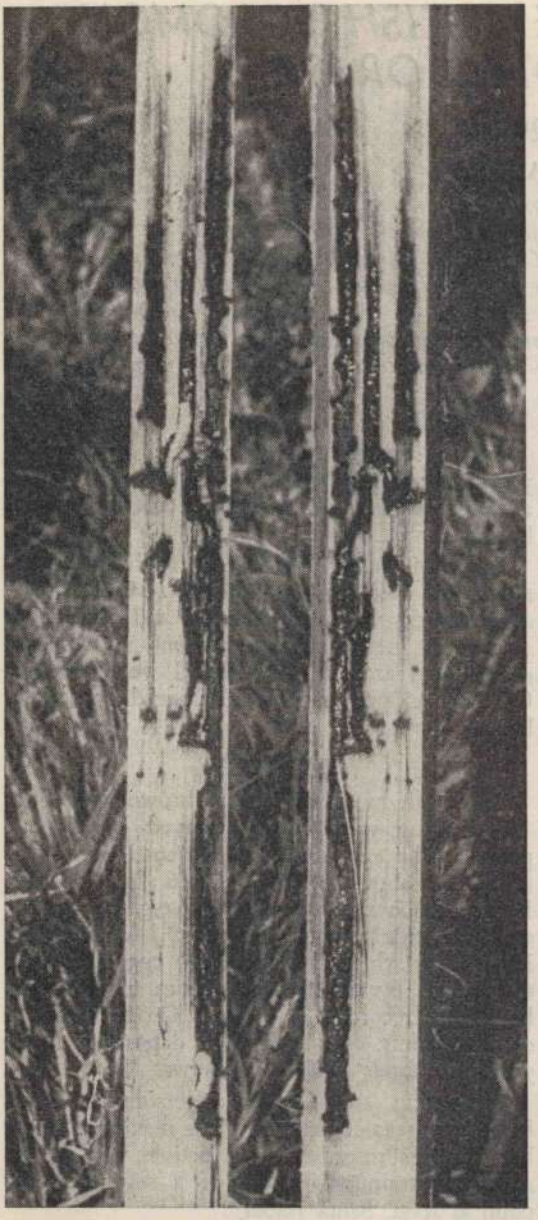

Plate I.—A petiole split in half to show extensive tunnelling by the coconut petiole borer (three late instar larvae are obvious).

site studies showing that most eggs are laid on the youngest petioles.

The mean head capsule width of larvae from ninth youngest petioles is significantly greater at the five per cent. level than the mean head capsule width of the larvae from the second youngest petioles.

Plate II.—Coconut petiole borer attack symptoms on the underside of the basal leafletless area of a petiole.

Table 1.—Egg sites on young palms.*

		Petiole Age.†									
		1	2	3	4	5	6	7	8	9	10
Eggs	No.	1	5	9	4	1	2	0	0	0	0
	per cent.	4.5	23	41	18	4.5	9	0	0	0	0

* Data obtained from sixty-seven five-year old palms at Tolana, Santa Isabel on 3.1.1964. Palms had an average of sixteen petioles.

† Petiole age=1 is used to describe the youngest petioles, petiole age=2 are second youngest petioles, etc.

Table 2.—Larval instar distribution on young palms.

	Larval head capsule width.*			
		Mean.‡	Standard deviation.‡	Number measured.
Petiole age †	2	0.07	0.03	255
	9	0.12	0.06	167

* Data obtained from seven-year-old palms at Rasa, Santa Isabel 1963-1964.

† As in *Table* 1.

‡ Measurements are in inches.

The maximum number of larvae recorded in a petiole was eight in a second youngest petiole of a seven-year-old palm at Rasa, Santa Isabel.

The last larval instar almost tunnels out of the petiole before pupating; a thin petiole tissue 'window' is left at the end of the tunnel in which pupation takes place. This 'window' is broken by the pupa just prior to emergence of the moth. Pupae were noted in ninth youngest petioles and not in second youngest petioles (Rasa, Santa Isabel 1963-1964).

Monthly observations at Rasa on Santa Isabel in 1963, had suggested that eggs were not laid in every month. Convincing evidence of this was obtained later, as shown in *Table* 3.

Although 75 per cent. of the palms at Tolana showed signs of damage (January, 1964), the percentage of palms bearing newly laid eggs never exceeded thirteen during the course of observation.

Dipterous pupae were found in larval tunnels on three occasions, twice on Santa Isabel and once on Choiseul. If this fly is a parasite, it would not appear to be of any significance in biological control.

In February and in July, 1963, a nymph of *Salomona* sp. (Orthoptera : tettigonoidea) was found inside a late instar tunnel. If this grasshopper is a predator, its value in biological control is doubtful.

Older petioles which have been ripped open exposing larval tunnels were occasionally noted; the identity of this predator is unknown.

Dead larvae and pupae were frequently found in tunnels. Detailed examinations of dead larvae by the Division of Invertebrate Pathology of the University of California have not revealed fungus, nematode or protozoan infection nor any indication of bacteriosis.

DISCUSSION.

Further study of the coconut petiole borer is required before any control measures can be given. In particular, other host plants must be investigated and their influence established on attack by the coconut borer in the thick secondary growth of coconut plantings.

The biological control fauna should be thoroughly investigated to indicate methods of increasing its influence in reducing damage.

Finally the effect of coconut palm condition on the borer and its damage should be considered and modified appropriately by managing the secondary growth of plantings, i.e., by providing secondary growth that does not include

Table 3.—Monthly variation in numbers of eggs laid on young palms.*

*		Date.															
		1964.												1965.			
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
Total eggs on seventy-five palms.	Observed on youngest three petioles	....	0	3	0	0	6	16	24	33	26	....	6	19	0	0	4
	Estimated on all petioles	....	0	4	0	0	9	23	35	48	38	....	9	28	0	0	6

* Data obtained from five-year-old palms at Tolana, Santa Isabel.
Estimated using data presented in *Table* 1.

hosts of the coconut petiole borer, that encourages the biological control fauna, and that improves nutrition of coconut palms whilst at the same time increasing the resistance of coconut palms to the coconut petiole borer.

Brown (1958) noted the restricted distribution within the Solomons of another coconut pest *Amblypelta cocophaga* (Hemiptera : coreidae) ; the premature nutfall bug occurs on the New Georgia group, Guadalcanal and Malaita. Now with the record of another pest in the Solomons with restricted distribution, the introduction of inter-island quarantine should be considered.

The dangers of transporting coconut frond material from one island to another should be publicised using all mass media. Legislation and enforcement of legislation is probably impracticable, so further research should be done to ensure the availability of control methods following the accidental introduction of the coconut petiole borer to other islands.

Inter-territory quarantine should prevent the coconut petiole borer being introduced to the Territory of Papua and New Guinea, Bougainville neighbours Choiseul.

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(Accepted for publication November, 1968.)

LIGHTNING STRIKE OF CACAO AND LEUCAENA IN NEW BRITAIN

DOROTHY E. SHAW * AND R. J. VAN VELSEN †.

ABSTRACT.

A description is given of a condition, attributed to damage by lightning strike, involving 31 *cacao and about* 200 *interplanted* Leucaena leucocephala *trees at two sites on a plantation in New Britain. Symptoms consisted of sudden partial or full defoliation and death of bark, followed by discolouration of wood inwards and downwards, resulting in death of branches and some trees. Recovery occurred in all but six cacao and several* Leucaena *trees left after sampling of partially damaged specimens.*

INTRODUCTION.

Occasionally reports have been received from planters in Papua and New Guinea of lightning strikes of cacao. In some cases the date of the strike was not precisely known, as symptoms were usually not noticed until weeks later. In other cases strikes were not reported until months after the reputed event, so that it was impossible to work out the sequence of symptoms on the damaged cacao.

One planter in New Britain, however, notified the Department as soon as he noted suspected lightning strike damage. As the authors are not aware of any published description of lightning strike on cacao or any associated shade tree, the following description is given of the symptoms of the reputed strike in New Britain.

It is hoped that cacao specialists in other countries will record the symptoms shown by cacao and shade trees after lightning strikes so that information will be accumulated on the time lapse before onset of symptoms, the extent of damage to individual trees, the time to recovery, if any, and the size of the areas affected in different situations.

INITIAL OBSERVATIONS.

On 7th May, 1965, a report was received by the junior author at the Lowlands Agricultural Experiment Station, New Britain (in New Guinea) of a condition in cacao (*Theobroma cacao* L.) and *Leucaena leucocephala* (Lam.) de Wit. (the interplanted shade tree) at a nearby plantation. The owners and some of the staff were of the opinion that the condition was of recent occurrence, the trees having previously been in excellent health. They presumed that it was the result of a lightning strike on the property during a storm said to have occurred on 13th April.

The plantation was visited on 7th May by the junior author, who reported that one large and one small area were affected, the details of which were as follows :—

Site 1.—Trees situated on a ridge. Twenty-five cacao trees affected as indicated in *Figure* 1 and approximately 200 *Leucaena* in the rows of cacao. The extent of damage varied from one dead branch per tree to the complete death of the tree.
No scorching was noticed on the cacao (which was 9 to 18 months old and up to 4 ft. (1.2 metres) high) nor on the *Leucaena* (up to 15 ft. (4.6 metres) high).

Site 2.—Six cacao trees with tips of branches dead. Six *Leucaena* surrounding the cacao with dead tops and trunk to within 4 ft. (1.2 metres) of the ground ; upper leaves shed but seed attached. (Cacao three and one-half years old).

The positions of the affected trees at Site 1 are shown in *Figure* 1. Only those *Leucaena* with completely dead tops are marked in the diagram ; *Leucaena* with partially dead tops, that is, with one or more branches dead, are not shown. These extended along the rows of cacao outside the area of *Leucaena* with dead tops.

Specimens of the affected cacao and *Leucaena* forwarded to Port Moresby were examined by

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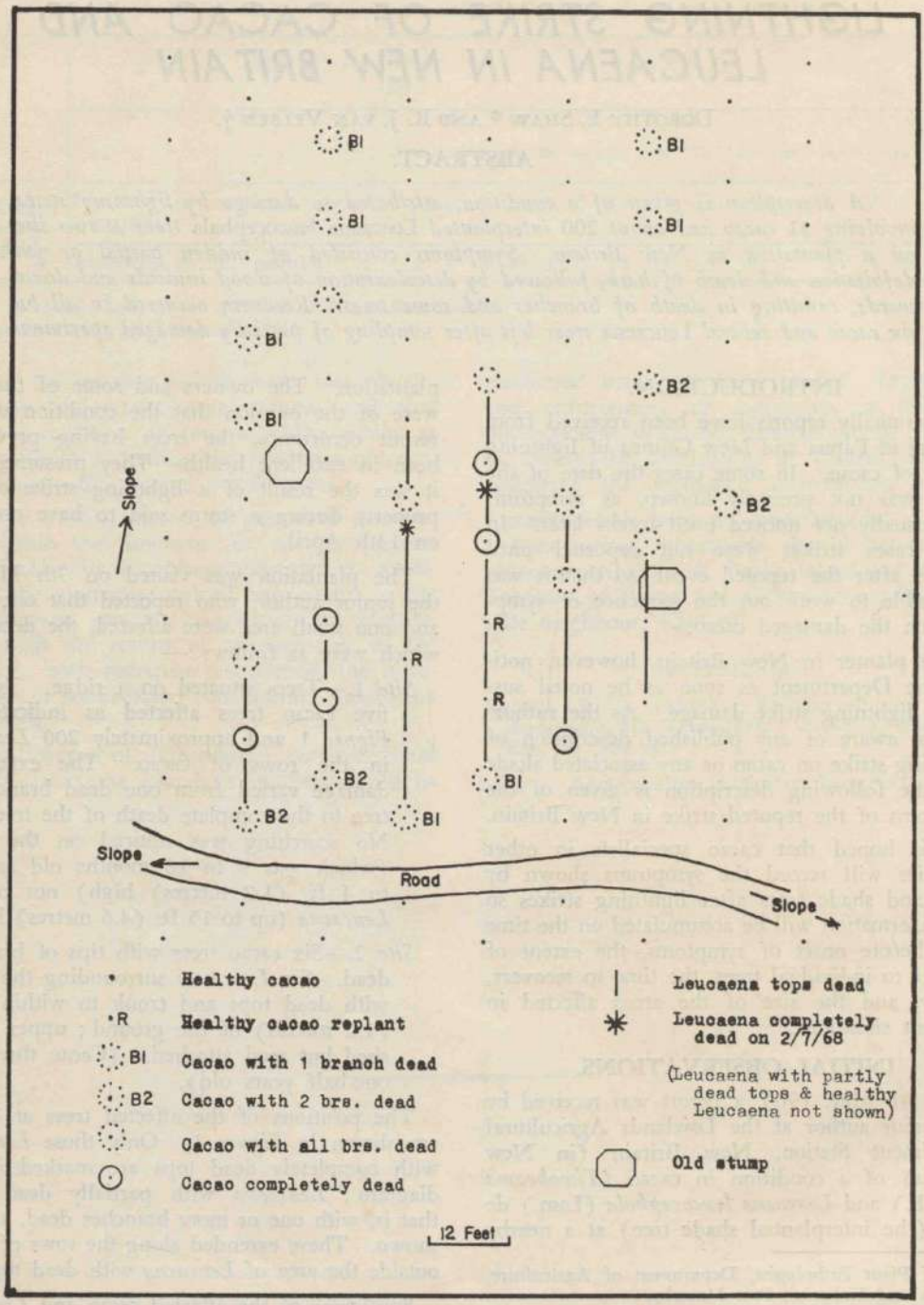

Figure 1.—Positions of affected cacao and *Leucaena*.

the senior author. The main symptoms on cacao were death of the branches preceded by death of the bark, with consequent lifting of the bark and blackening of the outside of the underlying wood, with deterioration preceding downwards. The main symptoms on *Leucaena* were death of the bark and discolouration of the underlying tissue inwards and downwards. Leaves of both cacao and *Leucaena* not already shed when dispatched had fallen during transit.

CONDITION OF THE TREES ON 25TH MAY, 1965.

Cacao.

On 25th May the senior author visited the plantation but no dead or dying leaves were present on the affected cacao at that time.

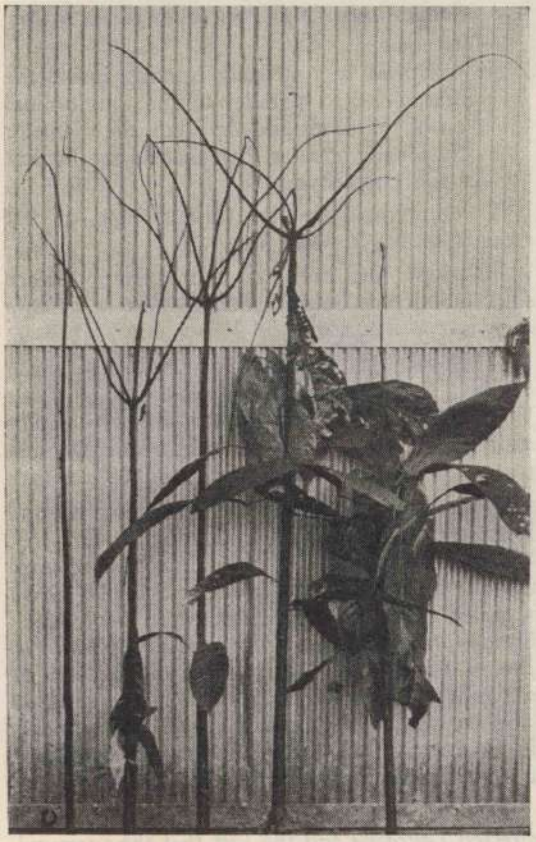

Plate I.—Young trees with dead tips but healthy bases, except tree marked "D" which was completely dead.

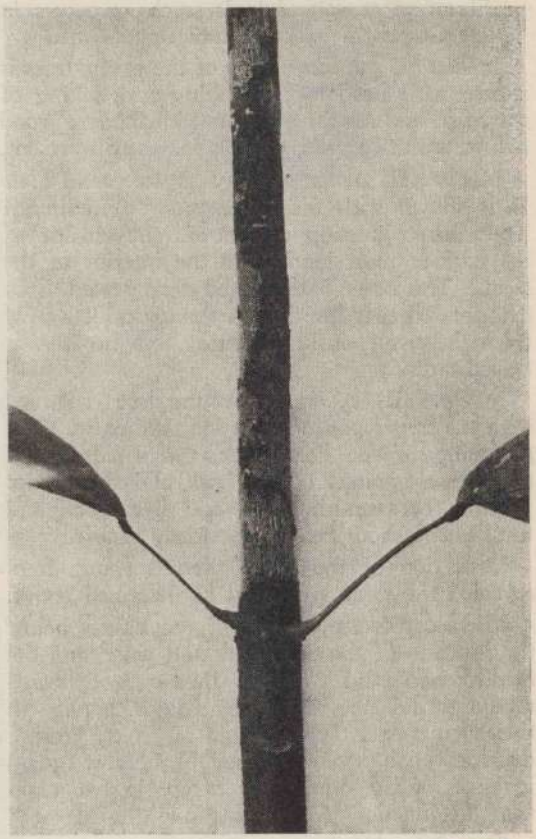

Plate II.—Trunk of young tree showing dead top with shrinking and flaking of bark and abrupt junction with healthy wood, with two green healthy leaves still present.

Most of the dead wood had been cut off the affected cacao trees at Site 2 before the visit. One of the trees with the trunk and several branches still standing was found to have secondary fungi growing on the bark of the trunk. When split, the wood was discoloured nearly to ground level. The tree would have died soon afterwards as the cambium could not have functioned very much longer.

Further specimens of young affected cacao at Site 1 were examined on the plantation and later in the laboratory. *Plate* I shows five young trees from this area; four had dead tips but healthy bases and one (marked 'D') was completely dead. Defoliation of the dead parts of each seedling had occurred but there was no

proliferation of lateral buds, such as occurs in " New Guinea dieback " (Shaw unpublished).

In *Plate* II portion of one of the young trees is shown with dead top, shrinking and flaking of the bark, and abrupt junction with the live wood below, with two green healthy leaves still present.

In *Plate* III A, the same young tree as in *Plate* II is shown with the stem split longitudinally. The abrupt junction evident on the outside of the bark is most marked in the interior of the stem. The outer bark of the dead area was so deteriorated that the fibrous strands pulled away from the tissue during splitting, can be seen as frayed strands.

In *Plate* III B, another young tree is shown with the upper portion split longitudinally. The shrinking of the dead bark, the shredding of the fibrous strands of the bark and the abrupt junction between the dead and live wood and the healthy shoot below are clearly visible.

Dissection of the other affected young trees revealed the same symptoms as described above.

Microscopic examination of the tissues below the junction of the dead bark and wood and the healthy bark and wood of the seven dissected seedlings did not reveal any fungal hyphae in the xylem vessels (as is found in " New Guinea dieback " (Shaw unpublished)) or any fungal invasion of the other cells except in two cases near the junction in many sections studied.

Secondary fungi were present on the dead tissue, as is common in New Guinea. No fungus which could be recognized as a primary pathogen was isolated from the tissues below the junction.

The death of the bark before the discolouration of the internal wood and the later discolouration of the internal wood inwards from the bark (as evident in the specimens examined in Port Moresby), the quick death of the branches, the absence of stimulated axillary buds and the absence of hyphae in the xylem all distinguish the condition reported here from " New Guinea dieback ".

Leucaena leucocephala.

Dead branches were still evident on the trees when examined. However, regrowth from many of the *Leucaena* branches below the dead portions of the trunks had already occurred when the trees were examined on 25th May.

The most noticeable feature of the specimens was again the deterioration of the bark which in most cases preceded discolouration of the wood. In some cases the junction between the dead bark and wood and the healthy undiscoloured wood below was abrupt (*Plate* IV A).

In a few cases the junction was not distinct—a diffuse edge occurred, the affected wood having a ' blue ' tinge as in blue staining of timber (*Plate* IV B).

Microscopic examination of some of the ' blue stain ' areas of the *Leucaena* revealed—

(i) brown septate hyphae running through the parenchyma cells of the rays at right angles to the main axis of the stem ;

(ii) hyphae rambling sparsely throughout the xylem vessels, i.e., lacking the definite orientation of those in the parenchyma ; and

(iii) hyphae very sparsely running inside the fibres, oriented parallel to the longitudinal axis of the fibres and the stem, the diameter occasionally smaller than that of the hyphae in the parenchyma.

A longitudinal section through one of the areas is shown in *Plate* V.

Isolations in nutrient agar after surface sterilization consistently yielded *Botryodiplodia theobromae* Pat. from the ' blue stain ' areas.

Some of the affected *Leucaena* had been attacked by scolytid beetles as shown in *Plate* VI A and B. Blackening of the tissues immediately surrounding the scolytid damage, and especially longitudinally from it, is most marked.

Specimens of the scolytids were collected, and later sent by the Senior Entomologist (Dr. J. J. H. Szent-Ivany) to Professor E. Schedl of Austria for identification. Professor Schedl (1968) reported that the specimens were Scolytidae : *Eccoptopterus spinosus* Oliv. and *Xyleborus perforans* Woll. In previous correspondence on scolytids Professor Schedl had stated that *E. spinosus* might be primary as well as secondary in its attacks but that *X. perforans* is mostly found as a secondary pest.

From the position of the scolytid attack on the affected *Leucaena* and the fact that the surrounding unaffected *Leucaena* was free from the insects, it is likely that in the present case both species were secondary.

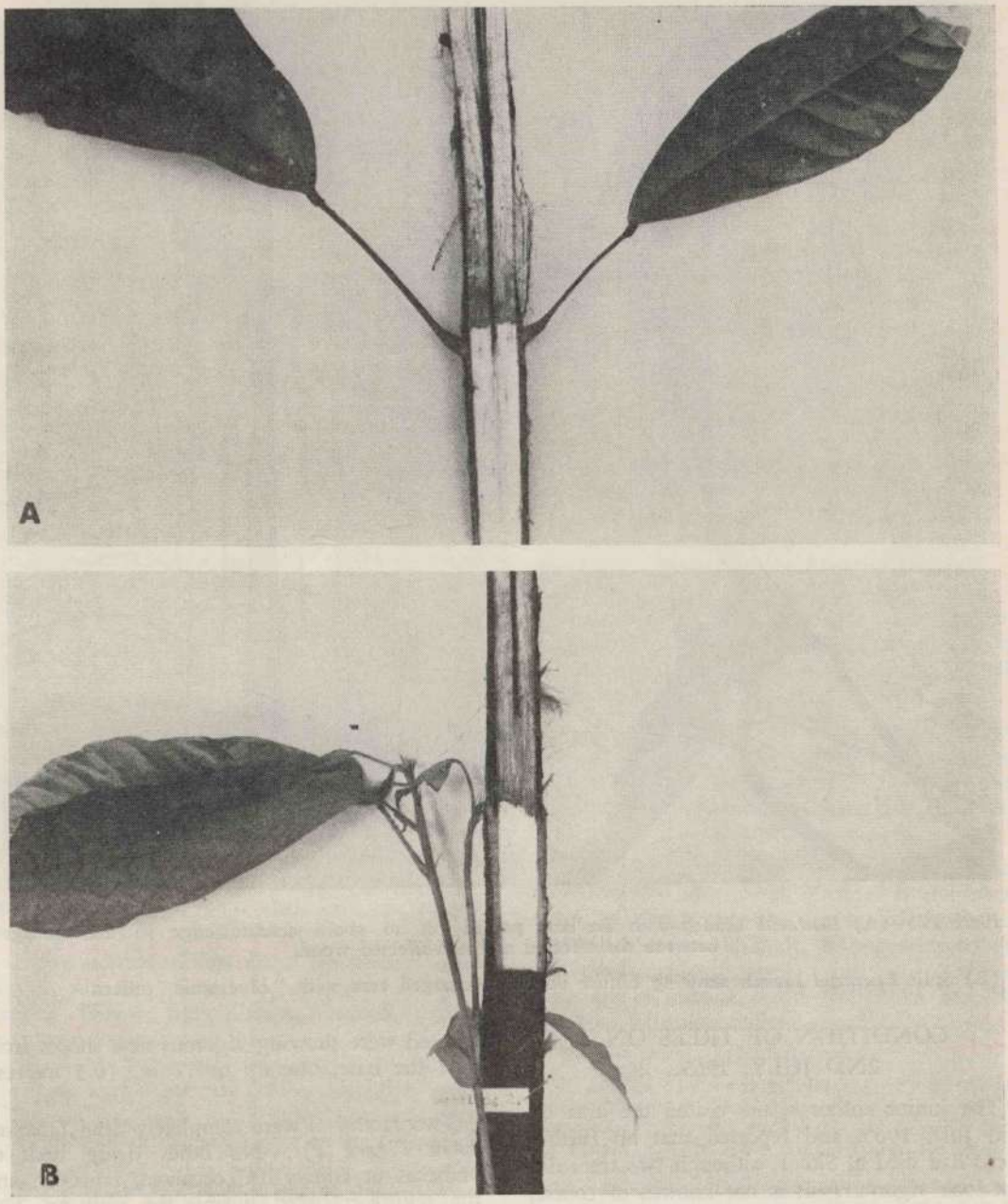

Plate III.—(A) Portion of trunk shown in *Plate* II split longitudinally showing abrupt junction between affected and healthy wood.

(B) Another seedling split longitudinally to show abrupt junction and shredding of deteriorated bark.

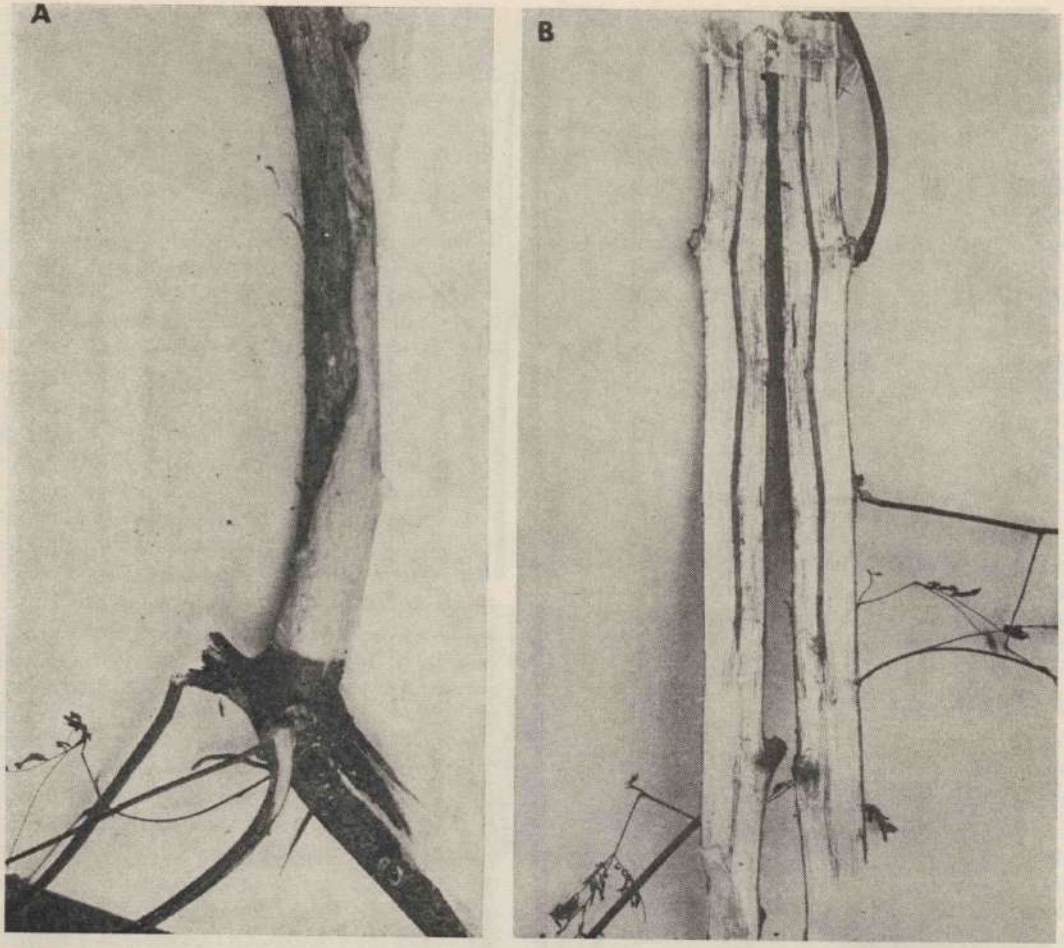

Plate IV.—(A) *Leucaena* branch with the bark peeled off to show definite edge to the damage between the affected and non-affected wood.

(B) Split *Leucaena* branch showing diffuse edge of damaged area with "blue stain" effect.

CONDITION OF TREES ON 2ND JULY, 1965.

The junior author again visited the area on 2nd July, 1965, and reported that no further cacao had died at Site 1, although two trees did not look vigorous. It is not known, of course, whether the seedlings sent to Port Moresby and the six partially alive seedlings out of the seven uprooted and studied by the senior author on 28th May would have recovered. Four of the remaining seedlings which had been partially affected were showing vigorous new shoots from near the base, one up to 12 in. (0.3 metres) long.

Two *Leucaena* were completely dead (marked * in *Figure* 1). No other dying back of branches or trunks had occurred, however, and the regrowth noted during the visit on 28th May was now vigorous and up to six ft. (1.8 metres) long.

No further dead wood was found on cacao or *Leucaena* at Site 2 and regrowth on the *Leucaena* was up to five ft. (1.5 metres) long.

Plate V.—Section through "blue stain" area of damaged *Leucaena*, showing strongly orientated brown hyphae in the parenchyma but relatively few hyphae in fibres and xylem. x 250.

DISCUSSION.

The condition described herein is not similar, as far as the authors are aware, to any condition described for cacao or *Leucaena leucocephala* overseas.

While the abrupt junction between the dead and the healthy cacao wood recalls the Ghana dieback described by Crowdy (1947) and Owen (1956), it differs in the quickness of the death of the tissue (according to the planter and staff) and the fact that the condition was confined to one large and one very small area, in several hundred acres of non-affected cacao.

The condition differs from tip dieback with abrupt junction found occasionally in New Guinea (Shaw unpublished), which usually occurs on overexposed cacao and again is not confined to a precise area amply shaded by *Leucaena*, as was the case on the plantation under discussion at least until the *Leucaena* was affected at about the same time as the cacao.

The condition also differs from progressive "New Guinea dieback" as this is characterized by indefinite margin, brown streaking of the healthy wood below the dead tissue, slow defoliation, stimulation of lateral buds, shortening of internodes and other symptoms (Shaw 1963 and unpublished).

No apparently sudden defoliation of *Leucaena* with death of branches has been recorded in the Territory previously, either in conjunction with a similar condition on cacao or separately.

It seems unlikely to the authors that the present condition was progressively pathogenic because of the quick recovery of both the cacao and the *Leucaena* and the fact that no spread occurred to neighbouring plants.

From the evidence of the owners and staff, and from the information obtained in the macroscopic examination of the sites and the specimens and the microscopic study, it is considered that the dead and damaged cacao and *Leucaena* especially at Site 1 could well have been the result of lightning strike.

ADDENDUM.

While this paper was in press Mr. C. A. Thorold kindly drew to the authors' attention the reference by Entwistle, P. F., in *Ann. Rept. W.A.C.R.I.*, 1958-59 (pages 37-38) 1960, listing borers recorded on cocoa following damage either by root fungus or lightening strike, and the reference of Wharton, A L., *Agriculture and land use in Ghana* Ed. J. Brian Wills, Oxford Uni. Press, pp. xviii + 504 (p.341), 1962. Wharton described the circular patches of blasted trees, with wilt, the dead leaves remaining attached to the trees, followed by invasion by borers and secondary fungi and recovery of peripheral trees.

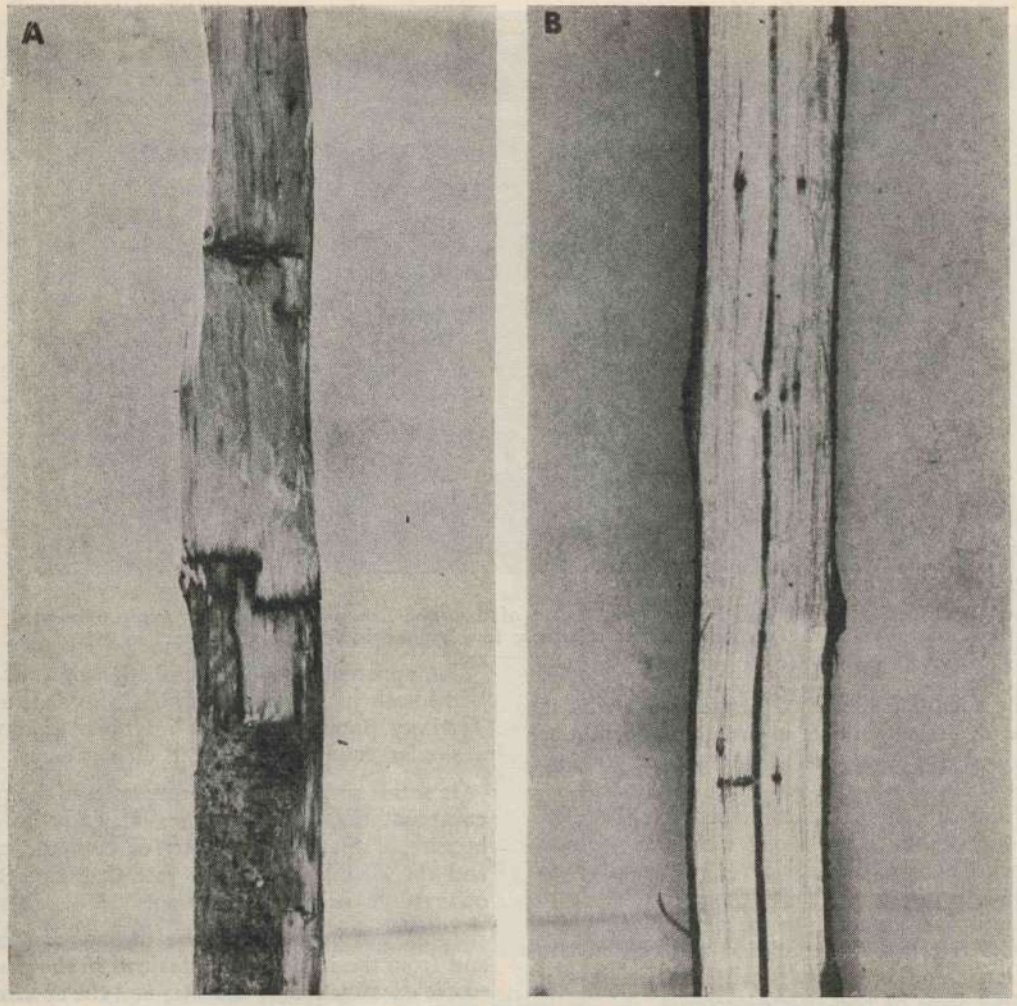

Plate VI (A) Portion of peeled *Leucaena* branch showing damage by scolytids and blackening of the tissue surrounding the holes.
(B) Split *Leucaena* branch showing internal position of the scolytid holes with blackening of the surrounding tissue and longitudinal staining from the holes.

ACKNOWLEDGEMENTS.

Dr. J. J. H. Szent-Ivany is thanked for his help in sending the scolytid specimens to Austria, and to Professor K. E. Schedl for carrying out the identification.

Mr. A. W. Charles kindly read the manuscript.

The owners and staff of the plantation are thanked for assistance given during the visits to the sites.

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(Accepted for publication January, 1969.)

LIGHTNING STRIKE OF CACAO IN NEW BRITAIN.

P. G. HICKS *.

ABSTRACT.

The external symptoms following lightning strike of cacao and Leucaena leucocephala *are described. Six cacao trees died and four* L. leucocephala *lost their crowns in the eight months following a single blast.*

LOCATION.

During a severe thunderstorm at a plantation near Keravat, New Britain, on 15th March, 1967, a severe blast was heard at 1900 hours at the homestead. On 18th March a foreman noticed several dying trees nearby.

All trees in the vicinity were closely inspected by the author on 19th March, 19th April, 9th May and 17th July, and again on 8th November, by which time the symptoms were indistinguishable from those resulting from other causes.

The homestead and affected area are situated on a hilltop on about the same level as the surrounding hills, which are divided by gullies up to 100 metres (300 ft.) deep. The alternate *Leucaena leucocephala* and cacao trees were planted about 1960 on a 4 x 2.3 metre (13 x 7.5 ft.) rectangular design and some of the *L. leucocephala* had been removed (*Figure* 1). At the time of the strike the cacao was about five metres (16 ft.) high and the *L. leucocephala* about seven metres (22 ft.).

SYMPTOMS.

The most frequent early indication of the strike of cacao was drooping of leaves which became chocolate-brown in colour and persisted on the tree. On 19th March it was apparent that some green leaves had been shed but this was not noted at the later inspections. Scolytid borers sometimes invaded the trunk before any obvious foliar symptoms appeared, but in other cases the tree was almost dead before scolytid invasion. Some trees did not develop definite symptoms until several weeks after the strike and then developed severe symptoms but others declined immediately. There appeared to be no consistent relationship between location, tree height or tree size and symptom pattern. Trunk bark immediately below badly affected limbs died, in most cases, to ground level.

Leucaena leucocephala showed wilting of leaflets without immediate collapse of whole leaves. Fresh symptoms were noted on some trees several weeks after the strike. As with the cacao, severe foliar symptoms were sometimes preceded by scolytid invasion. Several trees died back to about one-half of their original height and then produced several shoots which formed a crown lower than the original. Bark low on the tree rarely died in large patches unless the whole tree died.

An unidentified forest tree about 150 metres (500 ft.) east of the cacao strike, on the edge of the hilltop had partly wilted the day after the blast.

SEVERITY.

The affect of the blast on the remaining *L. leucocephala* and cacao trees is indicated in *Figure* 1.

Six cacao trees, marked A to F, died as a result of the blast. Four *Leucaena* trees died back below the original crown. *Leucaena* I was forked near ground level, one branch dying completely, the other losing about 10 per cent. of its leaves ; J died and K and L died back to form a new crown four metres (13 ft.) from the ground.

The numbers represent the estimated percentage leaf losses sustained by *Leucaena* and cacao which finally recovered without the whole crown dying.

CONCLUSION.

The concurrence in time and place of the strike and death of trees leads the author to conclude that the damage described was the result of lightning.

(Accepted for publication January, 1969.)

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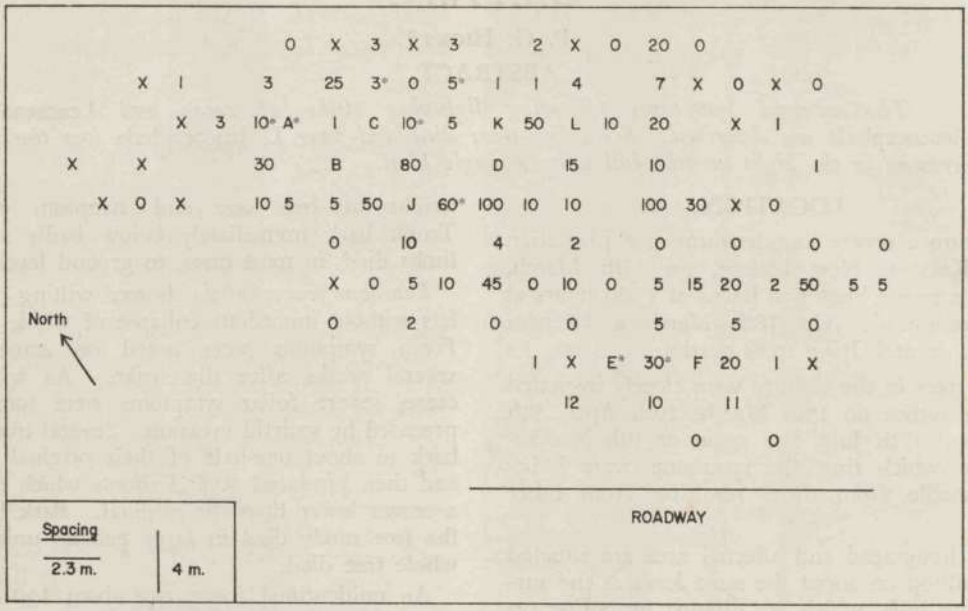
Area affected by lightning strike.

FIG. I



O = Unaffected cacao
X = Unaffected *Leucaena*
* Scolytid borers invaded stems. The area is surrounded by cacao and *Leucaena* except for the roadway. Figures indicate per cent. leaf loss, final recovery of tree.
A-I. See text.

COMPOSITION OF A NUMBER OF TROPICAL AND SUBTROPICAL FEEDSTUFFS

J. A. SPRINGHALL, M.B.E., E.D., M.V.Sc, M.R.C.V.S.

ABSTRACT.

The search for protein rich feedstuffs is a continuous one, particularly in developing areas where there is direct competition for food between man and animals.

This study indicates the nutritive value of certain feed ingredients available in the Territory of Papua and New Guinea by analysing their crude protein, fat, fibre, dry matter and ash contents. The analyses could assist in the formulation of livestock rations making use of such materials.

INTRODUCTION.

The search for protein-rich feedstuffs is a continuous one, particularly in developing areas where there is direct competition for food between man and animals. In these areas, in many cases it would be more advantageous to feed the protein directly to the population than to pass it through pigs and poultry. However, where pigs and poultry raising form a major industry, it is generally accepted that some protein material must be fed to these animals to increase production. Increased growth rates of both pigs and poultry, and increased egg production should in turn improve the diet and health of the people.

This study indicates the nutritive value of certain feed ingredients by analysing their crude protein, fat, fibre, dry matter and ash contents (*Table* 1). The analyses could assist in the formulation of livestock rations making use of such materials. The results are expressed on an air dry basis, which is the most convenient form for the calculation of rations. Materials containing a high proportion of water may be used ; the method of calculation is given in the respective handbooks for feeding poultry and pigs in the Territory (Ross and Springhall 1965 and Springhall and Burgess 1969).

A number of the figures shown have been made available by the Department of Agriculture, Stock and Fisheries, Territory of Papua and New Guinea ; others have been extracted from an F.A.O. (1965) publication ; whilst the remainder have been obtained by the author. Many of the materials have been analysed and test fed to livestock [Ross and Springhall (1963) ; Springhall (1964) ; Ross and Springhall (1965) ; Springhall and Ross (1965 a and b) ; Springhall (1967 a and b) ; Springhall and Dingle (1967) ; and Springhall (1968)].

MATERIALS AND METHODS.

All analyses were based on the methods of the Association of Official Agricultural Chemists (1955). Comments on the suitability of the feedstuffs are based on literature reports or unpublished results of the author. They refer to both pig and poultry nutrition.

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Table 1.—Composition of a Number of Tropical and Subtropical Feedstuffs.

All figures are percentages, calculated on an air dry basis.

(The symbol 0 indicates that the amount present is negligible ; .... indicates unknown.)

ENERGY SOURCES.

Feedstuff.	Crude Protein.	Crude Fat.	Crude Fibre.	Dry Matter.	Ash.	Remarks.
Banana (ripe, unpeeled), *Musa Sapientum*	3.9	1.0	1.0	86	6.7	**
Bean seed (French), *Phaseolus vulgaris*	20.6	3.5	3.7	85.2	2.7	Should not be used in quantities greater than 15% for poultry.

Table 1.—Composition of a Number of Tropical and Subtropical Feedstuffs—*continued.*

ENERGY SOURCES—*continued.*

Feedstuff.	Crude Protein.	Crude Fat.	Crude Fibre.	Dry Matter.	Ash.	Remarks.
Breadfruit seeds, *Treculia africana*	15.1	1.1	1.1	83	1.3	**
Cocoa bean pods, *Theobroma cacao*	12.3	37.2	7.7	87	4.0	Toxic for poultry even in small quantities.
Copra, *Cocos nucifera*	8.3	62.7	6.4	96	1.4	Oxidises if not treated with antioxidant.
Carob pods, *Ceratonia siliqua*	6.1	0.7	10.8	84.9	2.3	** More than 5% may depress poultry growth.
Dates, dried with kernel, *Phoenix dactylifera*	2.1	0.8	4.8	74.3	4.2	** Up to 10% may be included in chick rations.
Dates, dried	3.1	0.8	3.4	78.9	2.0	** ditto.
Manioc, unpeeled (Cassava, Yuca, Tapioca), *Manihot utilissima*	2.2	0.6	2.2	88	2.5	** As some varieties contain prussic acid, it is suggested that the material be dried or heated before use.
Manioc roots, peeled	1.8	0.6	0.9	88	3.4	**
Manioc meal, roots dried	2.8	0.5	5.0	94.4	2.0	** Up to 10% may be used in chick rations.
Sugar cane Molasses, *Saccharum officinarum*	3.0	0	0	73.4	8.6	*
Passionfruit seed, *Passiflora edulis*	10.7	24.1	44.4	93.8	1.6	
Papaw fruit *Carica papaya*	4.1	0.4	5.1	88	6.8	*
Peanut kernel (whole unextracted), *Arachis hypogaea*	30.4	48.3	0.9	94.3	2.4	
Rice Paddy, rough rice, *Oryza sativa*	7.9	1.8	9.0	88.8	5.2	**
Rice, Brown	9.1	2.0	1.1	87.8	1.1	**
Rice, Polished	7.4	0.4	0.4	87.8	0.5	**
Rice Bran	12.4	13.6	11.6	90.8	13.3	Rancidity is a problem.
Rice Pollard	11.0	12.0	10.0	....	....	**
Sago, *Metroxylon spp*	0.6	0.4	0.6	88	0.4	It is suggested that 30% be maximum quantity used for poultry, but up to 50% for pigs.
Sweet Potato tuber meal	4.9	0.9	3.3	90.2	4.1	As above.
Taro tubers, *Colocasia* spp.	3.8	0.6	13.1	88.6	4.7	As above.
Water lily seeds, *Nymphaea copensis*	15.0	....	....	91.2	....	*
Yam tubers, unpeeled, *Dioscorea spp.*	7.3	7.3	2.2	88	3.7	**
Yam tubers, peeled	6.1	0.4	1.2	88	3.3	**
PROTEIN SOURCES (animal origin).						
Beche-de-mer (Sea slug, Trepang)	44.3	1.2	0	95.9	42.3	Should not be used in quantities greater than 10%.Ca & P levels should be adjusted.
Crab meal	74.0	14.8	....	90	....	**
Fish bone meal	39.9	....	2.0	91.9	44.0	**

Table 1.—Composition of a Number of Tropical and Subtropical Feedstuffs—*continued.*

Feedstuff.	Crude Protein.	Crude Fat.	Crude Fibre.	Dry Matter.	Ash.	Remarks.
PROTEIN SOURCES (animal origin)—*continued.*						
Fish meal (Tilapia)	59.3	2.8	0	88.9	25.0	Quantities greater than 10% of the ration may taint the flesh.
Lobster Waste meal	36.8	5.7	0	88.6	39.5	**
Shrimp meal	46.7	2.8	11.1	89.7	27.8	**
Silkworm Pupae meal, not extracted	58.9	18.1	5.4	92.0	3.2	**
PROTEIN SOURCES (vegetable origin).						
Coconut meal, hydraulic or expeller process, *Cocos nucifera*	21.2	6.7	11.2	93	6.5	**
Coconut meal, solvent process	21.4	2.4	13.3	91.1	6.6	**
Cottonseed oil cake *Gossypium* sp.	41.6	6.0	10.7	92.9	6.5	**
Cowpea seeds, *Vigna unguiculata*	22.5	2.2	1.1	91.3	3.5	**
Lupin seeds, sweet yellow, *Lupinus luteus*	39.8	4.9	14.0	88.9	4.5	*
Mango kernels, *Mangifera indica*	33.3	9.8	2.3	94.8	1.7	Not recommended for poultry.
Peanut oil cake, *Arachis hypogaea*	43.4	6.8	12.1	91.8	5.5	**
Pea seeds, *Pisum sativum*	23.0	1.3	6.5	90.8	3.5	
Pea pods	59.7	1.5	17.8	82.7	5.2	
Pyrethrum marc *Chrysanthemum cinerariifolium*	14.9	2.1	24.9	71.3	7.6	
Rubber seed cake meal, *Hevea brasiliensis*	30.2	8.7	5.0	91.2	5.6	** Prussic Acid (?).
Sesame Oil meal, *Sesamum indicum*	43.3	9.0	6.2	93.7	11.6	**
Soybean, raw, *Glycine max*	40.7	17.6	5.3	92.3	4.7	Recommended for adult poultry only.
Soybean oil meal	44.0	4.9	5.9	91.0	6.2	
Sunflower seed cake meal, *helianthus annuus*	49.5	4.9	5.4	94.3	5.9	** Hulls must be removed.
GREEN FEEDS AND FIBROUS MATERIALS.						
Abika, *Hibiscus manihot*	15.6	2.9	11.2	86.9	16.9	
Albizia stipulata	26.9	2.1	25.1	94.7	6.6	
Banana stems	6.5	2.1	27.6	92	12.9	Very low nutritive value.
Banana leaf	14.6	4.4	21.3	91	11.7	
Centrosema pubescens	15.0	2.1	40.5	94	5.4	Should not be used in quantities greater than 15% for poultry.
Cocoa pods, *Theobroma cacao*	8.4	2.5	23.5	90.6	6.7	Should not be used in quantities greater than 5% for poultry.
Coffee pulp, *Coffea arabica*	9.2	2.1	20.6	91.8	8.9	Should not be fed to poultry.
Crotalaria anagyroides	22.1	3.4	21.0	91.1	5.4	More than 10% may depress growth of poultry.
Elephant grass *Pennisetum purpureum*	10.5	1.8	32.2	92.2	11.5	Should not be used for chickens.

Table 1.—Composition of a Number of Tropical and Subtropical Feedstuffs—*continued.*

GREEN FEEDS AND FIBROUS MATERIALS—*continued.*

Feedstuff.	Crude Protein.	Crude Fat.	Crude Fibre.	Dry Matter.	Ash.	Remarks.
Guinea grass, *Panicum maximum*	10.0	2.1	33.0	92.8	10.5	
Kikuyu grass, *Pennisetum clandestinum*	17.4	5.4	10.9	78.9	6.9	
Leucaena leucocephala	28.0	4.5	11.8	89.9	6.0	
Passionfruit shell	6.9	0.9	24.9	90.1	5.4	More than 5% may depress growth of poultry.
Papaw leaf meal, *Carica papaya*	23.4	10.6	7.6	92.7	12.5	
Peanut hay	8.6	4.3	29.8	95.6	7.5	Can be fed to pigs up to levels of 20%.
Peanut plant meal	16.6	20.5	23.3	88.0	8.2	Can be fed to adult birds up to levels of 30%. For chickens, quantities should not exceed 20%.
Pit Pit, *Saccharum robustum*	5.7	2.0	12.6	89	14.4	*
Russian Comfrey, *Symphytum officinale*	17.3	1.4	8.0	88.9	13.6	
Sweet Potato tops	15.8	2.5	17.5	91	11.1	
Taro leaf	23.5	....	13.7	88	8.6	*
Taro shoots	5.2	0	....	88	3.2	*
Tephrosia candida	15.7	3.6	32.5	92.2	5.0	Should not be fed to poultry in quantities greater than 5%.

Note.—* D.A.S.F., T.P.N.G. figures.

** F.A.O. figures (corrected to air dry basis).

ACKNOWLEDGEMENTS.

The analyses reported by the author were financed by a grant from the Reserve Bank of Australia, Rural Credits Development Fund, to whom the writer is grateful. Sincere thanks are also due to Miss L. Hardy and Mr. David Cox for technical assistance.

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(Accepted for publication November, 1968.)

NEW RECORDINGS OF ANIMAL PARASITES IN PAPUA AND NEW GUINEA.

N. T. TALBOT.*

ABSTRACT.

An addendum to The Distribution of Infectious and Parasitic diseases of Animals in Papua and New Guinea 1964 *is presented.*

A total of forty (40) *new animal parasite recordings are included, as well as new host and regional isolations for those previously reported.*

A brief history is given of the possible origin of parasites exotic to Australian livestock, as well as observations on some of them.

INTRODUCTION.

The following list of parasites is an addition to the host-parasite check list published by Egerton and Rothwell (1964).

For convenience the format of the original publication is adhered to as closely as possible.

The list includes all parasitic organisms identified since that year, as well as necessary changes in the distribution list for parasites previously reported.

An interesting features of a number of the parasites present in domestic animals in this Territory is that they have not, to date, been reported from the Australian mainland.

The majority of parasitic organisms infecting livestock in this country have been introduced from the Australian states with importations of farm animals, particularly in the period before the second world war. A number of economically important helminth and arthropod parasites, however, were almost certainly introduced from the Philippines, Malaya and the East Indies with sporadic introductions of livestock during the early part of this century.

During the era of German administration of New Guinea (1884-1914), Water buffalo (*Bubalis* sp.), Fallow deer (*Dama* sp.) and some Asian Zebu breeds of cattle were imported from the East Indies to the plantations of the mainland and the New Guinea Islands region.

The date of introduction of the Rusa deer (*Cervus timoriensis mollucensis*), to Netherlands New Guinea is uncertain, but is thought to have occurred early in this century. These animals have adapted to the wet coastal environment of southern Papua remarkably well and have spread from Merauke eastwards to the Fly River in large numbers. A small group of these animals, introduced to the Port Moresby area some decades ago, have managed to perpetuate themselves in the swampy hinterland despite intensive hunting.

The introduction of pigs probably occurred with prehistoric migrations from South West Asia ; carbon dating of pig bones recently excavated from the highland areas suggest that this animal formed part of the diet of indigenous races as long as 5,500 years ago (White 1968). Importations of pigs to coastal areas has also occurred with European exploration and occupation in recent centuries.

Poultry were probably also introduced with early migrations directly from South East Asia. Their small body size renders them easily transportable and it is certain that considerable exchange of birds has been carried on in villages near the West Irian border. Consequently a number of intestinal parasites of poultry recorded from the West Sepik and Western Districts have not been yet observed in other areas of the Territory.

It is evident from the preceding data that ample opportunity existed for the introduction to New Guinea of parasites exotic to the Australian livestock population. Examples of such

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parasites may be found in poultry, pigs, dogs, cats and cattle throughout the Territory.

Some of the parasites tabulated below were recorded during a series of surveys carried out on village-owned pigs and poultry in various areas of the Territory; others were identified during routine post-mortem examination of material presented to the Veterinary Laboratory at Kila Kila, Port Moresby.

HOST CHECK LIST OF NEWLY RECORDED ANIMAL PARASITES 1964-1968.

HORSE—*Equus caballus*
- NEMATODA : *Tridontophorus tenuicollis.*
- ACARINA : *Amblyomma cyprium cyprium.*
  Ixodes confusus.
- DIPTERA : *Gastrophilus haemorrhoidalis.*

OX—*Bos taurus.*
- PROTOZOA : *Eperythrozoon spp.*
- TREMATODA : *Ceylonocotyle streptocoelium.*
- CESTODA : *Moniezia benedeni.*
- NEMATODA : *Onchocerca gutturosa.*
- ACARINA : *Haemaphysalis bancrofti.*
- PHTHIRAPTERA : *Damalinia bovis.*
  Linognathus vituli.

PIG—*Sus papuensis.*
- PROTOZOA : *Balantidium coli.*
- NEMATODA : *Globocephalus longemucronatus.*
  Gnathostoma doloresi.
  Strongyloides ransomi.
- ACARINA : *Amblyomma cyprium cyprium.*
  Demodex spp.
  Haemaphysalis papuana papuana.

GOAT—*Capra hircus.*
- SIPHONAPTERA : *Ctenocephalides felis felis.*

DOG—*Canis familiaris.*
- PROTOZOA : *Babesia canis.*
- CESTODA : *Taenia hydatigena.*
- NEMATODA : *Ancylostoma braziliense.*
- ACARINA : *Haemaphysalis papuana papuana.*
- DIPTERA : *Chrysomyia megacephala.*

CAT—*Felis domesticus.*
- TREMATODA : *Euparadistomum sp.*
- CESTODA : *Joyeuxiella pasquelei.*
- NEMATODA : *Ancylostoma tubaeformae.*
- ACARINA : *Haemaphysalis novaeguineae.*
  Ixodes spp.

MOUSE—*Mus musculus.*
- CESTODA : *Hymenolepis diminuta.*
- NEMATODA : *Syphacia obvelata.*
- ACARINA : *Myocoptes musculinus.*

RAT—*Rattus norvegicus.*
- NEMATODA : *Gongylonema spp.*
- ANCANTHOCEPHALA : *Moniliformis moniliformis.*

BUFFALO—*Bubalis spp.*
- DIPTERA : *Siphona exigua.*

DEER—*Cervus timoriensis mollucensis.*
- ACARINA : *Haemaphysalis novaeguineae.*
- DIPTERA : *Chrysomyia bezziana.*

WALLABY—*Wallabia sp.*
- ACARINA : *Haemaphysalis bancrofti.*

GUINEA PIG—*Cavia porcellus.*
- ACARINA : *Ornithonyssus bacoti.*

FOWL—*Gallus gallus*
- CESTODA : *Amoebataenia sphenoides.*
- NEMATODA : *Capillaria anatis.*
  C. contorta.
  Heterakis putaustralis.
- ACANTHOCEPHALA : *Mediorrhynchus gallinarum.*
- ACARINA : *Speleognathopsis galli.*
- PHTHIRAPTERA : *Eomanacanthus stramineus.*
  Lipeuris heterographus.

DUCK—*Anas boschas domestica.*
- NEMATODA : *Ascaridia galli.*
- ACARINA : *Megninia spp.*

PIGEON—*Goura sp.*
- NEMATODA : *Ascaridia spp.*

CORMORANT—*Phallacrocorax sp.*
Contracaecum spiculigerum.

MAGPIE GOOSE—*Anseranas semipalmata.*
- PHTHIRAPTERA : *Acidoproctus hilli.*
  Holomenapon goliath.

EGRET—*Egretta Garzetta.*
- TREMATODA : *Clinostomum complanatum.*

REGIONAL DISTRIBUTION OF ANIMAL PARASITES 1964-1968.

The Territory of Papua and New Guinea has been divided into three regions as follows :—

Papua (PAP)—The Territory of Papua ;

New Guinea Mainland (NGM)—The north-eastern portion of the mainland of New Guinea ; and

New Guinea Islands (NGI)—Manus Island, New Ireland, New Britain, Bougainville and other lesser islands.

The New Guinea Mainland and New Guinea Islands together constitute the Trust Territory of New Guinea.

P = Present.

PR = Present but rare.

.... = not recorded.

An asterisk denotes a new parasite recording for the Territory, as well as new host and regional distribution recordings.

PROTOZOA.

Organism.	Host.	PAP.	NGM.	NGI.
Babesia argentina	Cattle	P *	P	....
Babesia canis *	Dog	P	....	....
Balantidium coli *	Pig	P	P	....
Eimeria deblieki	Pig	P	P *	....
Eperythrozoon sp *	Cattle	P	....	....

TREMATODA.

Organism.	Host.	PAP.	NGM.	NGI.
Ceylonocotyle streptocoelium *	Cattle	P	P	....
Clinostomum complanatum *	Egret	P	....	....
Euparadistomum sp *	Cat	PR	....	....

CESTODA.

Organism.	Host.	PAP.	NGM.	NGI.
Amoebataenia sphenoides *	Fowl	P	P	P
Davainia proglottina	Fowl	P *	P	....
Hymenolepis diminuta *	Mouse	P	P	....
Joyeuxiella pasquelei *	Cat	P	....	....
Moniezia benedeni *	Cattle	P	P	....
Taenia hydatigena *	Dog	P	....	....

NEMATODA.

Organism.	Host.	PAP.	NGM.	NGI.
Ancylostoma braziliense	Dog	PR	....	....
Ancylostoma tubaeformae *	Cat	P	....	....
Ascaridia spp.	Pigeon	....	P	....
Capillaria anatis *	Fowl	P	P	P
Ascaridia galli	Duck	....	P	....
Capillaria contorta *	Fowl	....	P	P
Contracaecum spiculigerum *	Cormorant	P	....	....
Globocephalus longemucronatus *	Pig	P	P	P
Gnathostoma doloresi *	Pig	P	P	P
Gongylonema ingluvicola	Fowl	P *	P	P
Heterakis putaustralis *	Fowl	P	P	....
Mecistocirrus digitatus	Cattle	....	P	P *
Onchocerca gutturosa *	Cattle	P	....	....
Oxyspirura mansoni	Fowl	P	P	P *
Parascaris equorum	Horse	P *	P	....
Strongyloides ransomi *	Pig	P	....	....
Syphacia obvelata *	Mouse	P	....	....
Tetrameres spp.	Fowl	P	P	P *
Triodontophorus tenuicollis *	Horse	P	....	....

Regional Distribution of Animal Parasites 1964-1968—*continued.*

ACANTHOCEPHALA.			
Organism.	Host.	PAP.	NGM.	NGI.
Mediorrhynchus gallinarum *	Fowl	P	P	P
Moniliformis moniliformis *	Rat	P	....	....

ACARINA.				
Organism.	Host.	PAP.	NGM.	NGI.
Amblyomma cyprium cyprium	Horse *	....	P	P
	Pig *	P	P	....
Boophilus microplus	Horse	P *	P	P
Cnemidocoptes mutans	Fowl	P	P	P *
Demodex spp.	Pig *	....	P	....
Haemaphysalis bancrofti *	Cattle	....	P	....
	Wallaby	P	....	....
H. novaeguineae	Cat *	....	P	....
	Deer *	P	....	....
H. papuana papuana *	Dog	....	P	....
	Pig	....	P	....
Ixodes spp. (Nymph.)	Cat *	P	....	....
Ixodes confusus	Horse *	P	....	....
Megninia spp.	Duck *	P	....	....
Megninia cubitalis	Fowl	P	P *	P *
Myocoptes musculinus *	Mouse	P	....	....
Ornithonyssus bacoti *	Guinea Pig	P	....	....
Speleognathopsis galli *	Fowl	....	P	....

DIPTERA.				
Organism.	Host.	PAP.	NGM.	NGI.
Chrysomyia bezziana	Deer *	P	....	....
C. megacephala	Dog *	....	....	P
C. rufifacies	Cattle	P	P *	....
Gastrophilus haemorrhoidalis *	Horse	....	P	....
Simulium spp. *		....	P	....
Siphona exigua *	Buffalo *	....	....	P
	Horse	....	P	P *
Stomoxys calcitrans	Cattle	....	P	P *
	Horse	....	P	P *
TABANIDAE.				
Cydistomyia lorentzi *		P	....	....
Dasybasis anomala *		P	....	....
Mesomyia demeijerei *		P	....	....
Tabanus dorsobimaculatus *		P	....	....
T. innotabilis *		P	....	....

SIPHONAPTERA.				
Organism.	Host.	PAP.	NGM.	NGI.
Ctenocephalides felis felis	Goat *	P	....	....

PHTHIRAPTERA.				
Organism.	Host.	PAP.	NGM.	NGI.
Acidoproctus hilli *	Magpie goose	P	....	....
Damalinia bovis *	Cattle	....	P	....
Eomenocanthus stramineus *	Fowl	....	P	....
Goniocotes gallinae	Fowl	P	P *	P *
Heterodoxus longitarsus	Dog	P	P *	
Holomenapon goliath *	Magpie goose	P	....	....
Linognathus vituli *	Cattle	....	P	....
Lipeuris heterographus *	Fowl	P	P	P
Menapon gallinae	Fowl	P	P	P *

A total of 40 new animals parasites have been recorded from Papua New Guinea in the foregoing list. A further 30 organisms, previously recorded in 1964, have been reported from new hosts or regional areas within this Territory.

A number of these parasites were omitted from the 1964 host check list owing to misdiagnosis. A number of examples follow.

Joyeuxiella pasquelei is by far the most common cestode found in the urban cat population, but macroscopically it resembles *Diplylidum caninum* to such a degree that it has always been previously recorded as that parasite.

Miyazaki (1968) in examining specimens of *Gnathostoma* from New Guinea has identified them as *G. doloresi*; previously all had been reported as *G. hispidum*. Examination of specimens from a number of Territory areas would indicate that *G. hispidum* is not present, but complete survey results are not yet available.

Ancylostoma caninum and *A. braziliense* have both previously been reported from cats in Papua and New Guinea. Attention has already been drawn in the literature to the similarity existing between *A. caninum* and *A. tubaeformae* (Fitzsimmons 1961). *A. tubaeformae*, however, is a slightly smaller worm and has longer spicules in the male than has *A. caninum*. Of approximately 150 cats examined post-mortem since 1964, no heavy infestations of this parasite have been reported, nor has any obvious 'hookworm disease' been observed in kittens in the veterinary clinic. The parasite is rarely absent from the mid-small intestine, but has been found to date only as light infestations with no obvious signs of anaemia present in the host. It is to be expected that heavy infections could lead to the death of young cats. During the recent survey neither *A. caninum* nor *A. braziliense* has been observed in this host.

A number of canine parasites, although recorded as being present in this Territory have only been observed in recently imported dogs. The presence of *Trichuris vulpis*, the common whipworm inhabiting the caecum of the dog, has been diagnosed at both Lae and Port Moresby on microscopic examination of faecal smears. Clinical trichuriasis, however, has never been seen to date.

Taeniid cestodes of dogs have rarely been observed at post-mortem examination, the reason being that no close association exists between the host animal and other mammals capable of harbouring the intermediate stage of these parasites. Under Territory conditions, rarely does the situation arise where dogs have access to offal of domestic ruminants.

Since 1965 the quarantine screening of imported dogs has included cestocidal treatment both before and after their arrival in this Territory. Examination of faecal specimens to date has failed to reveal any adult segments of the hydatid tapeworm *Echinococcus granulosus*.

It would seem highly unlikely that either domestic or sylvatic cycles of hydatid disease could establish themselves in Papua and New Guinea. The closest association between dog and intermediate host animal exists in villages where pigs are sometimes killed *en masse* for tribal feasts. In New Guinea village life however, pigs are highly prized and dogs rarely would have an opportunity to ingest infected offal. Up to the present time, only one sterile cyst of *E. granulosus* has been observed in the liver of a cow at post-mortem, within this Territory.

During the past three years intensive surveys have been carried out on helminths of indigenous poultry and pigs, resulting in a number of new parasites having been recorded from both of these animals. *Gongylonema ingluvicola*—previously listed as rare in fowls (Egerton and Rothwell 1964) has now been described from poultry in all three regions of the Territory. As many as thirty worms have been collected from the crops of individual birds examined in the Rabaul area of New Britain. This helminth, however, appears to be of negligible pathogenic significance.

A number of species of *Heterakis*—the caecal worm of poultry—were also collected but their identification is not yet finalised.

During 1965-1966 approximately fifty rats were examined in the Port Moresby area for the presence of lung worm, *Angiostrongylus cantonensis*. Following on previous reports from other Pacific territories (Alicata and Brown 1962, Alicata 1963), it was decided to establish the presence and incidence of this parasite within the Territory owing to its public health significance. None of the animals examined however, were positive for *A. cantonensis*,

although one of the proven molluscan intermediate hosts, *Achatina fulica*, is present in this area.

An extension of this survey to other areas of Papua and New Guinea, and in particular the port towns of Madang, Wewak, Lae and Rabaul is indicated, in order to ascertain definitely whether this parasite is present.

SUMMARY.

An addendum to *The Distribution of Infectious and Parasitic diseases of Animals in Papua and New Guinea* 1964 is presented.

A total of 40 new animal parasite recordings are included, as well as new host and regional isolations for those previously reported.

A brief history is given of the possible origin of parasites exotic to Australian livestock, as well as observations on some of them.

ACKNOWLEDGEMENTS.

The author is indebted to officers of the following institutions who have aided in diagnosis of a number of parasites reported in the previous list :—

Dr. Nixon Wilson of the Bishop Museum, Hawaii.

Mr. S. Prudhoe of the Department of Zoology, British Museum of Natural History, London.

Dr. F. H. S. Roberts and Dr. K. R. Norris of the Division of Entomology, C.S.I.R.O., Australia.

Dr. J. Pearson of the Department of Parasitology, University of Queensland.

Dr. R. Domrow of the Queensland Institute of Medical Research, Brisbane.

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(Accepted for publication February, 1969.)

Deer in New Guinea.

PART II : A PRELIMINARY NOTE ON THE DISTRIBUTION OF DEER IN THE TERRITORY OF PAPUA AND NEW GUINEA.

M. C. Downes.*

ABSTRACT.

Two species of deer are recorded from the Territory of Papua and New Guinea, namely rusa (Cervus timorensis) *and axis deer* (Axis axis). *Small populations of rusa exist in separated locations at Port Moresby, Gazelle Peninsula of New Britain, and the Hermit Islands. A larger population in the plains of the Trans Fly River area is contiguous with that of Merauke in West Irian. Axis deer exist in small numbers on the outskirts of Madang.*

A preliminary account is given of the status and distribution of each group.

Bentley (1967) provided the first information on deer in the Territory of Papua and New Guinea. He reported deer of three species, namely rusa deer (*Cervus timorensis*), fallow deer (*Dama dama*) and axis deer (*Axis axis*), distributed in five separate localities. These are the Port Moresby area, Gazelle Peninsula of New Britain, the Madang area, the Hermit Group islands, and the Trans-Fly area of Papua (*Figure* 1). The present paper provides more detail of the distribution in these areas. The

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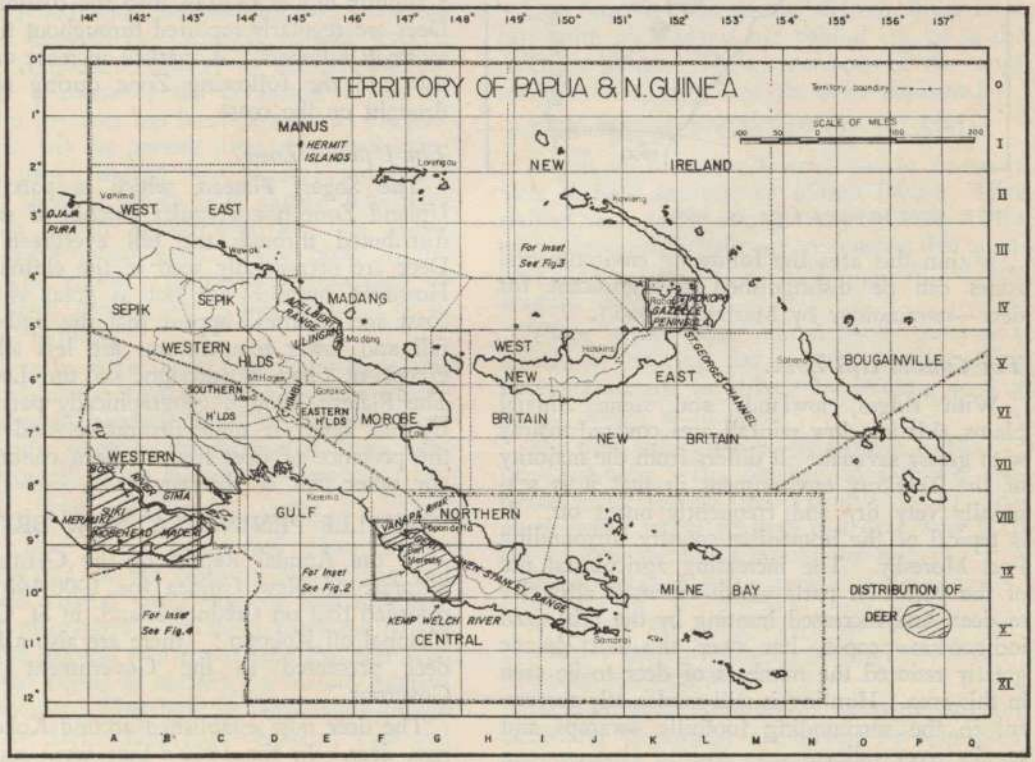
Figure 1.—Distribution of deer in the Territory of Papua and New Guinea.



existence of fallow deer at Madang has not been confirmed, only axis deer being identified in specimens and observations.

THE PORT MORESBY AREA.

In general the rusa deer in the Port Moresby area are distributed in the area bounded by the Vanapa River and Galley Reach on the west, by the edge of the rain forest on the lower slopes of the Owen Stanley Range on the northern or inland side, and by the Kemp Welch River to the east (*Figure* 2).

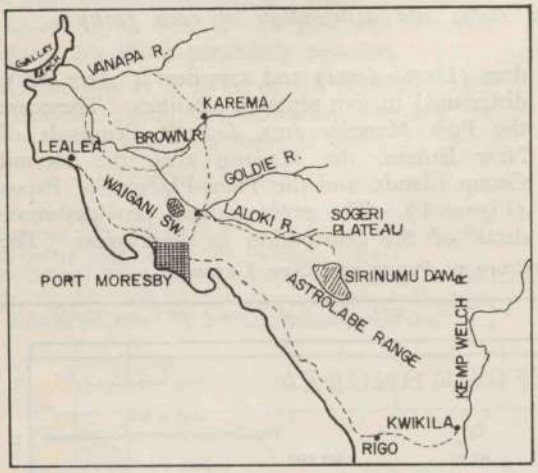


FIG. 2 PORT MORSEBY AREA OF PAPUA

Within this area the following environmental zones can be distinguished as significant for deer—terminology by Marbutt (1965).

The Coastal Hill Zone.

With ridges, lowlands and some alluvial plains, this is a low rainfall area covered mainly with grassy savanah. It differs from the majority of the Territory environment in that it is seasonally very dry and frequently burnt off. It is typical of the immediate country surrounding Port Moresby. The increasing agricultural use of the particular parts which are most attractive to deer, and increased hunting by the urbanized indigenous people, has over the last decade greatly reduced the numbers of deer to be seen in this area. Hunting is still moderately successful in the surrounding foothills, swamps and up the river valleys.

The Swamp Zone.

Appears to hold the greatest concentrations of deer at present. Along the edges of the swamps extensive areas of cover and food develop around the permanent or seasonal standing water. The Waigani swamp complex, less than eight miles from the centre of Port Moresby, still contains significant numbers of deer, though in lesser numbers since the drought of 1965, and increased shooting with shotguns.

Alluvial Plains Zone.

Consistent hunting takes many deer where the Swamp Zone intermingles with this Zone, for example along the Brown River from the bridge at Karema through to Galley Reach. This area contains some tall evergreen forest having extensive grassy patches, particularly associated with the swamps and meandering river channels and ' round-waters '.

The Foothills Zone.

Comprises most of the Astrolabe Range. This area is covered mainly with savannah but it has a slightly higher rainfall than the coastal plains. Deer are regularly reported throughout this zone in small numbers. A marked increase occurs in this and the following Zone during times of drought on the coast.

The Upland Zone.

The Sogeri Plateau, which is part of the Upland Zone has irregular patches of savannah distributed through the tall evergreen forest. Deer are occasionally seen in the cleared areas. However, numbers are not as great as on the coast and it would appear that the higher rainfall and lower temperatures are less attractive, except in times of drought on the Lowlands. The Plateau, though geographically part of the Upland Zone, is quite distinctive, and to date the presence of deer has not been confirmed in any other part of this zone.

GAZELLE PENINSULA, NEW BRITAIN.

In the Annual Report of the German Protectorate of New Guinea for 1900-1901, it is recorded that on Credner Island, in St. George's Channel off Kokopo : " there are also a few red deer presented to the Government by the Governor ".

The deer now established around Kokopo are rusa deer. In the 1950's they were commonly

seen on the roads and close to most of the stations during mornings and evenings. The limits of distribution appear to have been between Cape Gazelle on the east to Varzin and Toma on the west (*Figure* 3).

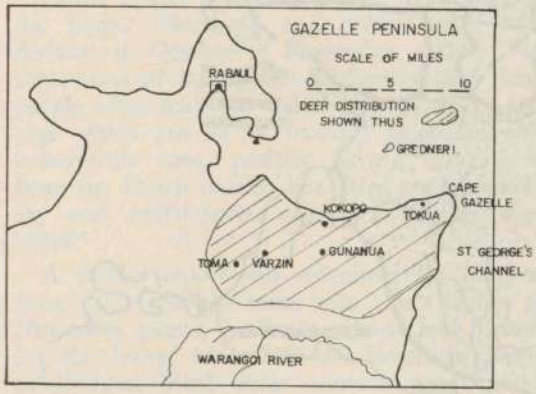


FIG. 3. APPROX. DISTRIBUTION OF RUSA DEER ON THE GAZELLE PENINSULA NEW BRITAIN.

Coincidental with the establishment of cocoa plantings beneath the extensive coconut stands, and the consequent activity in and around the accessible portions of the peninsula, a marked decline in the deer has been noted over the past ten years. At the present time only small numbers of deer (usually two to six) are rarely reported in areas which once carried hundreds. They are usually found near the few grassy areas, mainly kunai grass. They camp in the *Ficus* (wild rubber) plantations established by the Germans, coming out to feed at night or in the early morning.

No deer have yet been reported outside this coastal plantation fringe of the Gazelle Peninsula, although penetration of the back country, for example south to the Warangoi River, may be unrecorded owing to lack of observers.

THE MADANG AREA.

Deer have been established since before World War I on the outskirts of Madang and along the coastal roads and in the adjoining coconut plantations. In these parts the virgin country is tropical rain forest, and the deer feed where the forest is cleared for native gardens or plantations. They hide in dense *Ficus* growth during the day, coming out to graze at night and in the early morning.

Although locally the deer are called fallow, there is no evidence for this species as yet; all antlers and skins examined so far were axis. The numbers are small, the total being variously estimated between 50 and 150 animals, but there is little information on the size or outer boundaries of the population.

During investigations by Mr. G. J. O'Leary in October, 1968 (Departmental report), local residents readily identified pictures of axis antlers and skins as similar to the deer seen around Madang. The approximate limits of distribution extended from Binnen Harbour to Yabob village on the south, westerly to Sisiak village, and north and west to Meiro Plantation, including the *Ficus* forest used as the daytime refuge. The rain forest is broken by small patches of secondary growth on old garden sites and by present day gardening which is attractive to the deer.

An axis skull and skin taken several years ago was obtained. The known localities for deer in the Madang area are given in *Figure* 4.

Deer are reported in the Gumm River area, just south of Madang and behind Uligen in the Adelbert Range. These extensions of the range away from Madang have yet to be confirmed.

THE HERMIT GROUP OF ISLANDS.

A pair of rusa deer from a zoo in Australia were released in 1909 on Maron Island. They walked via a sandy strip to Arkeb Island. This pair subsequently built up to considerable numbers (Letter from H. R. Wahlen to A. Bentley, August, 1953).

When Arkeb and Maron were developed, mainly by clearing for coconut planting, deer were transferred or driven by hunting to Luf Island, which is all scrub.

The deer were reported by Cilento (1928) to be flourishing. The number on Luf was estimated to be 200 in 1953 (Bentley 1967). An unconfirmed report suggests that deer were present on Ninigo Island before the war.

THE TRANS FLY AREA OF PAPUA.

Rusa deer are present in large numbers west of the Fly River in Papua, having crossed from Merauke in West Irian.

In West Irian the deer at Geelvink Bay and Hollandia (Jajapura) are quoted by Van Bemmell (1949) as rusa imported by Lulofs from

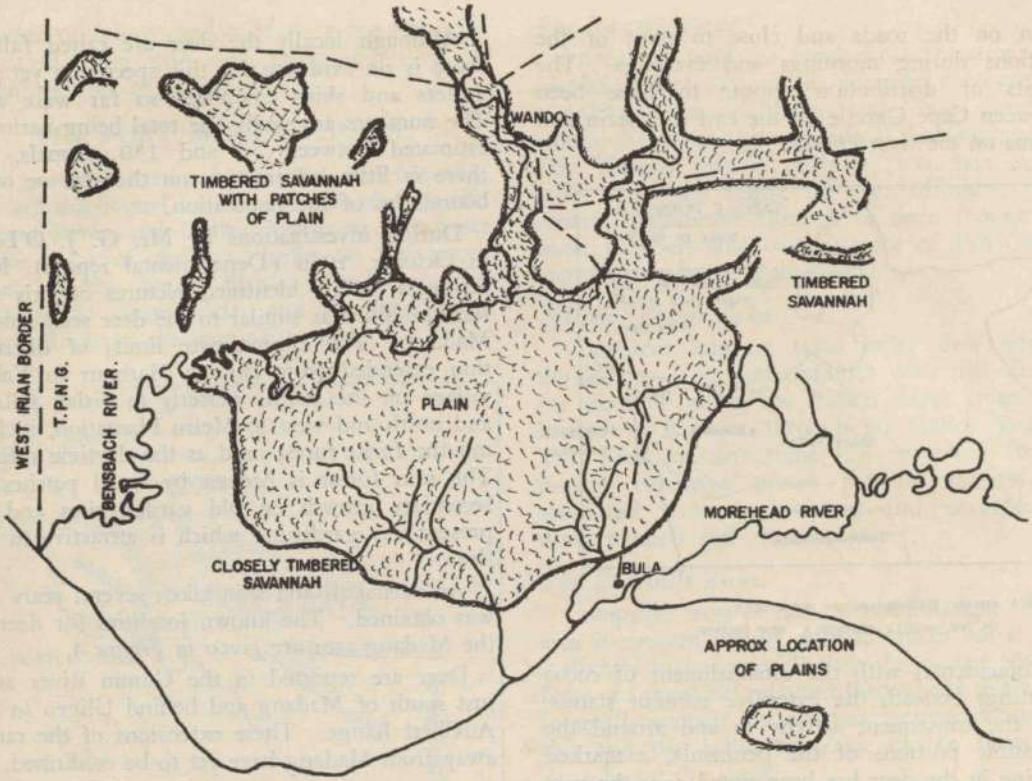


FIG.4 BULA PLAIN WESTERN DISTRICT OF PAPUA

the Halmaheras in 1920. Brass (1968) saw several deer of unidentified species on a walk in June, 1938, from Hollandia to Lake Sentani, where the rain forest had been much disturbed by native cultivation and had been replaced by grass. The deer on the Onin Peninsula are said by Van Bemmell to have originated from Ceram in 1913, having been brought there by Raedt van Oldebarnevelt. No mention is made by Van Bemmell of the deer at Merauke. Brongersma (1958) gives a photograph of rusa deer from West Irian.

Local reports put the introduction of deer to Merauke at about 1920. Numbers have greatly increased. In Papua the main concentration is on the large plains between the Bensbach and Morehead Rivers. Deer are occasionally shot in small numbers throughout the whole area south of the Fly River, where the native population is relatively sparse. They are occasionally shot by the natives as far north as Boset near the intersection of the Fly River with the border, some 120 miles from the coast ; at the few settlements such as Suki Lagoon and Maderi Plantation on the south bank of the Fly ; and as far east as Daru Island and in the islands in the mouth of the Fly estuary. The density of the deer population away from the plains of the south-west corner is low.

Deer were not heard of during the first and second Archbold Expeditions in 1934 and 1936-1937. The areas visited included open type vegetation about Lake Dariumbu on the Middle Fly, at Gaima on the Lower Fly, on Daru and the very extensive open areas in the Wassi Kussa areas—Brass (1968).

Local discussion places the first observation of deer at Suki Lagoon as early as 1938, when the station was established. There were few observers in the Western District at that stage and reports of the spread of the deer are difficult to interpret. Other informants recall seeing the first deer through their villages, for example in the Morehead area, as late as 1956 and even

in 1960 in some areas. If this is true, a considerable upsurge in numbers seems to have occurred in the late 1950's and early 1960's. The data from the few patrol reports seem to confirm this picture.

Patrol Officer Giffard reported on a visit to the Upper Morehead and Suki Census subdivision in October to November, 1956; "In some areas of bush game is plentiful and these people often hunt the wallabies, cassowaries and pigs which are to be found. Deer are also occasionally seen, probaly having come over from the Dutch border, but these are extremely shy and swift footed and are scarcely ever killed".

A similar report was submitted for May to June, 1957, for the same area. In October to November patrols in these districts and including the Lower Morehead and Bensbach census subdivisions listed other common native game but deer were not mentioned, whereas at the present time they are a feature of the landscape.

In May to June and October to November, 1967, deer were reported by the natives, but were very seldom seen. Tracks were seen by the party.

October, 1958, is the occasion of the first Patrol Officer's report of deer being seen in large numbers in the Trans Fly Census Division. In May to June, 1959, deer were very plentiful during the field trip and the carriers were able to eat venison every day. The native gardens at Oriomo were surrounded by strong fences, reputedly to keep out deer.

Through 1961 and 1962 deer were reported plentiful on each trip in areas where previously deer were not mentioned.

Occasional reports have been made of deer swimming to various islands off the coast and in the Fly River. It is probable that deer have crossed the Fly several times. However there is no evidence that they have spread far beyond the Fly River at this stage.

From 1965 to December, 1967, deer were shot commercially for meat in the vicinity of the Bensbach River. They were shot at night within a few miles of the river. The carcases, including only the hind and forequarters and the saddle, were frozen and flown to Port Moresby for shipment overseas. In all some 200,000 lb. of meat was exported in this period.

On 4th October, 1968, during a period of $2\frac{1}{4}$ hours, 15 north-south transects were flown by the author at 300 ft. over the plains between the Bensbach and Morehead Rivers. Over approximately 150 miles, some 4,250 deer were counted within the half mile band of country covered by the transect. They were clustered in small groups of 3 to 10 animals around the water holes along the creeks, and within the greener areas of the creek watersheds. Much of the plain was dry and without deer. Transposing these figures, an average of 57 per square mile, to the total area of about 100 square miles, the total number of deer on the plain that morning would be of the order of 5,000 to 6,000. Density of the deer within the scrub and forested area away from the plain would be lower, but a much greater area is involved, and the total population is unknown.

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(Accepted for publication February, 1969.)

Book Review.

AGRARIAN DEVELOPMENT IN PEASANT ECONOMICS.

ERIC CLAYTON, Pergamon Press, 1964. 154 pp. $Aust. 4.28.

Dr. Clayton's short book of 147 pages on agrarian development as a general concept draws heavily upon case studies of developments that have occurred in Kenya. In fact the first four chapters focus upon changes in Kenya involving migrations of people and the consequent closer settling and more intensive farming of the land. Naturally these new pressures brought about difficulties : new levels of productivity were needed to increase cropping output, and soil erosion severely threatened the existing cultivated lands.

Mainly in response to these particular difficulties the Kenyan agricultural authorities implemented a number of schemes intended to increase production and counter soil destruction. These measures included the encouragement of multi-enterprise farms, the provision of incentives to encourage production, group farming schemes, in particular to consolidate fragmented holdings and enclosed holdings. These measures were backed by farm planning and ecological studies. This brings Clayton to the main point of his book :

" The purpose . . . . is really to emphasize the need for a systematic and logical approach to the problems of raising agricultural productivity. Such an approach requires that due weight be given to the economic variables involved. It should be clear that technical knowledge alone, vital though this is, can only go so far in dealing with these problems ".

This quote is included in a chapter entitled *The Economics of Peasant Agriculture* which does little more than state that economics applies to developing countries and on peasant farms in the matter of the allocation of resources, as well as it does to other situations.

The remaining two chapters of the book seem rather out of place when compared with the theme of the earlier chapters, although they do fit into the broad subject suggested by the title of the book. The first is the problem of whether smallholder development should be fostered by the government or private elements. The second bears on the subject of land ownership and financing of rural development. These themes would seem to be quite inadequately dealth with and best left to volumes which specifically cover these subjects.

Of course what is of interest in the book is the relevance of the Kenyan experience to Papua and New Guinea. There are two major differences which are noted when the Papua and New Guinea situation is compared with that of Kenya, as exemplified by the objectives of Kenyan agricultural policy. One is the establishment of a stable peasant agriculture, which we already have in Papua and New Guinea, and the other is the need for farm planning to prevent soil erosion and consolidate scattered holdings. However, many of their efforts at rationalization of Agrarian systems have some bearing upon the organization of Papua and New Guinea's land settlement schemes. The policy for agriculture embarked on in the early 1950's " was based on land consolidation, farm planning and the rapid introduction of peasant-grown cash crops . . . . these reforms are leading to a commercialized agriculture which derives its impetus from private enterprise and initiative. This contrasts strongly with the many development schemes seen in post-war Africa which have been tightly controlled, leaving the cultivator with little freedom of action. Few of these schemes have, in consequence, been successful."

In conclusion Clayton qualifies his plea for the use of economic studies in peasant agriculture by stating that they should be related to :—

(1) Prevailing standards of husbandry ;

(2) Attitude of the peasant to economic incentives ; and

(3) Effectiveness of extension services.

The book does well to point out the role of economic planning and economic investigation in developing countries and to place on record the achievements of Kenya in agrarian development amongst smallholders. But, apart from from drawing those two facts to our attention, the book does little to bring to our notice new facts, solutions, or even stimulate the imagination to thinking on a new tack.

G. P. YEATS.

Port Moresby: V. P. Bloink, Government Printer.—A8406/7.69.