ASPECTS OF THE COCOA WEEVIL BORER *PANTORHYTES BIPLAGIATUS* GUER IN THE BRITISH SOLOMON ISLANDS PROTECTORATE

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ABSTRACT

Pantorhytes biplagiatus (*Guer*) *is a serious pest of cocoa in the British Solomon Islands. In some farms it has caused the death of up to* 50 *per cent of trees three years old and older, and in a trial plot yields were reduced by* 30 *per cent over a four year period.*

Insecticidal control is difficult and expensive. Control by hand removal of larvae and adults can be effective in small farms away from large infestations. This method is likely to prove tedious and expensive on larger plantations

Two other possible methods of control are discussed. The first is the introduction of the ant Oecophylla smaragdina (*F*) *to cocoa farms.* Oecophylla *is antagonistic to* Pantorhytes. *Lower numbers of larvae are to be found in trees on which* Oecophylla *is foraging. However, there are difficulties in introducing the ant into uncolonised young cocoa farms. These include competition from the ant* Technomyrmex detorquens (*Walk*), *enviromental factors, and possibly the availability of food. Further investigation of these factors is needed to determine the optimum timing for nest introductions.*

The second method is the use of less susceptible cocoa varieties. Amelonado and the progeny of clone Na32 were found to be less susceptible to Pantorhytes *damage than Trinitario. These types have a thinner smoother bark than Trinitario and the number of egg laying sites for* Pantorhytes *is probably therefore reduced.*

INTRODUCTION

Members of the genus *Pantorhytes* (Curculionidae, sub-family Pachyrinchinae are serious pests of cocoa in Papua New Guinea (Szent-Ivany 1961) and in the British Solomon Islands (Keevil 1966). Five species are known to attack cocoa in Papua New Guinea and of those *P. plutus* (Oberth); *P. batesi batesi* (Faust), and *P. szentivanyi* (Marsh) are considered the most serious. Only one species *P. biplagiatus* (Guer) has so far been identified on cocoa in the Solomons. This species does little damage in Papua New Guinea but it can cause tree mortalities of up to 50 per cent on small farms in the Solomons.

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LIFE HISTORY AND DAMAGE

Descriptions and illustrations of the important species in Papua New Guinea have been given by Szent-Ivany (1961) and Smee (1963). Adults and larvae of *P. biplagiatus* are shown in *Plate* I.

The life history of *P. biplagiatus* has not been studied in the British Solomons but G. S. Dun in a personal communication to the Department of Agriculture in 1961 gave the following information on the species. The eggs are laid in cracks in the bark of host plants. Some 10 to 17 days later the larvae emerge and immediately bore through the bark and tunnel into the sapwood parallel to the surface, but some 1.0 to 1.5 centimetres below it. They remain in these tunnels for up to six months and pupate within them. The adult female has

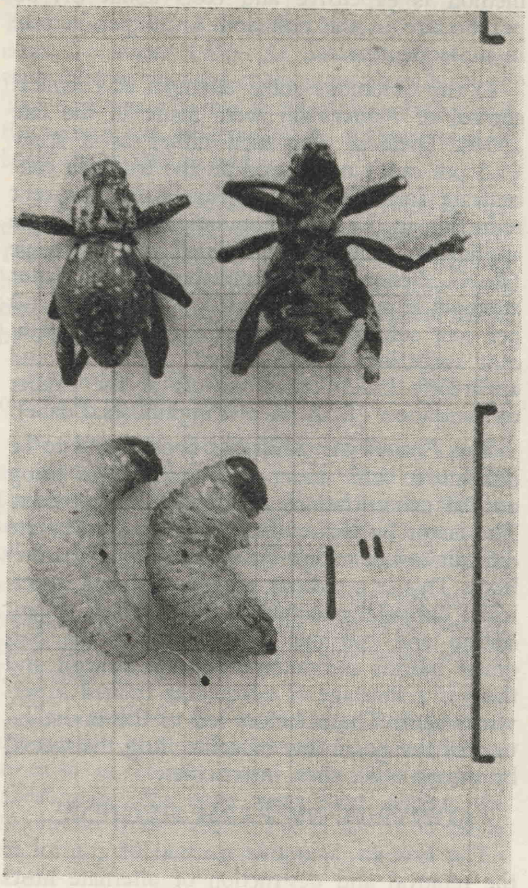

Plate I.—Adults and larvae of *Pantorhytes biplagiatus* Guer

a pre-oviposition period of from 14 to 21 days. The oviposition period lasts 160 days during which about 300 eggs are laid.

Dun did not state the conditions under which these observations were made. Both the pre-oviposition period and oviposition period quoted above are, however, shorter than for other species, e.g. 80 and 250 to 450 days respectively for *P. szentivanyi* (T. Bourke pers. comm. 1972).

The adults feed on the bark of young shoots, and this can cause twig dieback but generally the damage is of little consequence at the time of the attack. It may, however, give rise to a rough bark as the tree ages and provides more potential egg laying sites. The most serious damage is caused by the larvae. Larval damage is seldom seen in cocoa younger than 36 months. From 36 months to about the sixth year damage is usually restricted to the jorquette region. The tunnelling of the larvae often causes stem splitting and ring-barking of the branches which subsequently die. From the sixth year trees may be attached at the collar, on the trunk, at the jorquette, and on the main branches. Repeated attacks on the trunk and at the collar lead to a gradual dieback and eventually the death of the tree.

Phytophthora palmivora stem canker has been found associated with *Pantorhytes* damage. In a survey of 271 cankers, 12.2 per cent were associated with larval channels (Friend 1972).

ECONOMIC IMPORTANCE

P. biplagiatus occurs on all the main cocoa producing islands of the Protectorate. The highest level of infestation has, however, been found on Malaita Island where some two thirds of the Solomons' cocoa are planted. A survey of about 25 hectares of randomly selected farmers' plots throughout Malaita in 1967 showed that 13.4 per cent of the trees were infested by larvae. The per cent of trees infested in individual farms varied from nil to 56 per cent. The highest incidence of trees with larvae was, however, found in a subsequent survey in July 1968 on Dala Experimental Station, Malaita Island. Ninety-six per cent of the trees on a 1.6 hectares block of Trinitario cocoa were infested. The mean number of larvae per tree was 4.7, giving a population of 2,500 live larvae per hectare.

The effect of *P. biplagiatus* damage on yields in small farms is difficult to determine. From 1968 to 1971, however, eight plots of Trinitario cocoa were observed at Dala Station. Each of the plots consisted of 40 trees. The cocoa became infested in 1968. By December 1970, 50 per cent of the trees on four of these plots had been killed. The other four plots were less affected and only 17 per cent of the trees were killed in the same period. The mean yields of the heavily and lightly infested plots are compared in *Table* 1.

Over the four years recorded there was 30 per cent more cocoa produced on the lightly infested plot. In the last recorded year the

Table 1.—Effect of *Pantorhytes* infestation on the yield of Trinitario cocoa planted in 1964. Mean yields kg dry cocoa per hectare

Year	Infestation Level		Percent Increase
	A—high	B—low	B—A
1968	243	187	−23
1969	228	270	18
1970	235	350	49
1971	268	458	71
Total:	974	1,265	30
% Trees killed to December 1970	50	17	

difference was over 70 per cent as the tree mortality increased markedly in the heavily infested plot. It is likely that yield decreases of this order were found on many small farms.

CONTROL OF *PANTORHYTES* BY INSECTICIDES

Three methods of control of *Pantorhytes* have been tried in Papua New Guinea. The first was based on the fact that *Pantorhytes* adults do not fly. Experiments were carried out in the 1940s using 10 per cent DDT, and later other insecticides, incorporated in a sticky compound, applied as bands around the trunk (Dun 1955). Banding experiments were later abandoned for economic reasons (Szent-Ivany 1961). The second method, again directed at the adults, was tree spraying with DDT at high and low volumes at six weekly and two monthly intervals respectively. It was said to be effective (Anon. 1961) although Smee (1963) stated that there was no reliable method of control by insecticides.

The third approach was directed at the larvae and consisted of painting the larval channels with a 0.25 per cent solution of fenthion (O'Connor 1969). The recommendation has now changed to a 1.25 per cent solution of fenthion or dichlorvos (T. Bourke pers. comm.). A sophisticated technique based on spraying with trichlorphon (Dipterex) was also recommended (Anon. 1971). In heavy infestations the farms are sprayed on a six weekly cycle in the first year, reducing to a three monthly cycle in subsequent years. This method is expensive and costs about $A100 per hectare in the first and $A50 per hectare in subsequent years.

In the Solomons some attempts at chemical control of *Pantorhytes* were made in the late 1950s. Dieldrin was used either as a spray (1.5 per cent) or painted on the trunk in concentrate form. The spray gave a 50 per cent reduction in the adult population after a single application, but was considered too expensive (P. G. Fennemore unpublished data). Later attempts at spraying with 0.5 per cent and 1.0 per cent solutions of dieldrin gave no significant reduction in the weevil population and apparently killed cocoa flowers at the higher concentration (R. A. Keevil unpublished data).

The *Pantorhytes* adult has been found to be difficult to kill under field conditions using normal concentrations of common insecticides. The larvae by virtue of their feeding habits are difficult to kill except on an individual channel basis. This is a tedious procedure. Most insecticidal campaigns require a great deal of organization and constant suveillance. In the Solomon Islands communications are difficult and there is a shortage of adequately trained supervisory staff. These factors led to the investigation of the possibility of controlling the weevil by means other than insecticides.

CONTROL BY FARM HYGIENE

The first stage in this method of control is the removal and destruction of alternate hosts of the weevil. In the Solomon Islands five alternate host species are known (Maquillan 1964). They are *Pipturus argenteus* (Forst, F.) Wedd., *Mellochia umbellata* (Houtt), Stapf., *Trichosperma psillocladum.* Merr of Perry., *Cananga odorata* (Lamk) Hook F. et Thomas, and *Trema cannabina* (Lour).

From about the second year of planting the farm is carefully observed on an individual tree basis for the presence of adults and larvae. The larvae are either removed from the channels with a sharp pocket knife, or killed with a sharpened wire. Adults are picked from the trees and killed. Inspections are made at monthly intervals.

Until 1969 no serious infestation of *Pantorhytes* had been found on Dala Experimental Station. By July of that year a high population of larvae was found on a plot of eight year old Trinitario. This plot was observed in detail until December 1970. At the same time two plots of five year old cocoa were also observed. The first was adjacent to the infested plot and the second was separated from it by an area of bush about 100 m wide.

The incidence of larvae in the trees on the eight year old plot was 96 per cent in July 1969. The incidence of larvae had been reduced by hand picking to 50 per cent in July 1970 but 50 per cent of the trees had been killed by *Pantorhytes* by December 1970.

No larvae were found in the two five year old plots in July 1969.

By July 1970 the incidence of larvae on the adjacent plot of five year old cocoa was 10.1 per cent and larvae were found up to 100 m inside the plot. By December 1970, 27 per cent of the trees had been killed by the weevil.

Larvae were found in 3.2 per cent of the trees on the isolated plot by July 1970, but no trees had been killed by *Pantorhytes* up to December 1970.

This method of controlling the pest is apparently only effective as a preventative measure in young cocoa away from serious infestations. No costs were kept during the 29 month observation period, but it is likely that this method would prove expensive on larger plantations.

BIOLOGICAL CONTROL

The question of biological control of *Pantorhytes* was briefly discussed by Szent-Ivany (1961). He mentioned a braconid parasite and the apparent antagonism of the ant *Oecophylla smaragdina* (F), but his general conclusions were that the chances of such control in Papua New Guinea were remote. Recently, however, there has been considerable work on biocontrol agents in Papua New Guinea and some 50 parasites and predators are known (T. Bourke pers. comm. 1969).

In the Solomon Islands the apparent antagonism between *Oecophylla* ants and *Pantorhytes* was noted in the late 1950s. Keevil (1966) stated that a useful method of controlling the weevil was to introduce and encourage the spread of *Oecophylla* within cocoa farms. No quantitative data was available to establish the relationship between presence of *Oecophylla* and absence of *Pantorhytes*. In the 1967 surveys, it was found that both insects were irregularly distributed through the cocoa growing areas. There was, therefore, the possibility of a chance occurrence of one without the other.

In 1970 studies on the relationship between *Oecophylla* and *Pantorhytes* and the possibilities of introducing the ants to uncolonised cocoa plots were started.

Three farms were studied in which both the ant and the weevil were found together. Individual trees were inspected and the presence or absence of foraging *Oecophylla* and *Pantorhyts* larvae were noted. The results of this survey are shown in *Table* 2.

Table 2.—Per cent cocoa trees with larvae, old larval tunnels and freely foraging *Oecophylla* ants in three farms in Malaita Island, March 1971

Farm	Trees with Larvae	Trees with Old Tunnels	Trees with Ants
1	3.6	16.8	94.0
2	45.6	4.6	64.0
3	67.5	18.9	25.0

As can be seen, there is a definite decrease in the percentage of trees with larvae as the percentage of trees occupied by foraging ants increases. Many trees with ants had old larval channels but no sign of recent damage. This suggests that as the ants were spreading within the farm the *Pantorhytes* adults were driven away. The mathematical relationship between the presence and absence of both pests is shown in *Table* 3.

Table 3.—The relationship between the presence of *Pantorhytes* larvae and *Oecophylla* ants on three cocoa farms

	Farm 1	Farm 2	Farm 3
Trees with ants	68	404	472
Trees without ants	210	151	361
Totals	278	555	833

$Chi^2 = 174.23$.

Observations did not show that the ants were predators of either adults or larvae. When adult weevils were placed on colonised trees they were quickly surrounded by the ants and thrown from the tree. Control is probably effected through the prevention of egg laying as the *Oecophylla* keeps the *Pantorhytes* adult away from the tree.

In 1970 a series of observations on introducing and establishing *Oecophylla* into uncolonised young cocoa was started at Dala Experimental Station.

Various fruit trees on the station, including varieties of citrus, soursop and custard apple, support large colonies of *Oecophylla*. The ants form two kinds of nest, main nests which can be up to 60 cm long (*Plate* II) and small outlying nests which often consist of only two or three leaves pulled together (*Plate* III).

Only the former were used. In the early morning when the ants were not actively foraging the large nests were clipped intact from the fruit trees with secateurs and taken immediately to the cocoa plots. They were then placed in the jorquettes of the cocoa trees at a rate of 15 per hectare.

Nests were first introduced into six small plots of cocoa planted in 1964 under thinned forest, which is the usual shade for cocoa in the Solomons. The trees had been bearing since 1968. By March 1972, ants were still found foraging in four of the six plots and large new colonies had been formed in both cocoa and shade trees within these plots.

In 1970 it was recommended that all new plantings of cocoa should be on clear-felled land using the tree *Leucaena leucocephala* as shade (Friend 1970). All the subsequent work on the introduction of *Oecophylla* has been carried out on non-bearing cocoa under this type of shade. Whereas the *ad hoc* introduction of nests into bearing cocoa under forest shade was successful, this was not so in young cocoa under *leucaena*.

In one plot the *Oecophylla* nests were vacated within 24 hours and no sign of the ants could be found on either the cocoa or the shade. A second introduction was then made and the nests were observed at two hourly intervals from 7 a.m. to 5 p.m. It soon became apparent that the *Oecophylla* were being attacked and killed by a small black tent building ant *Technomyrmex detorquens* (Walk). Every tree in the plot was occupied by *Technomyrmex*.

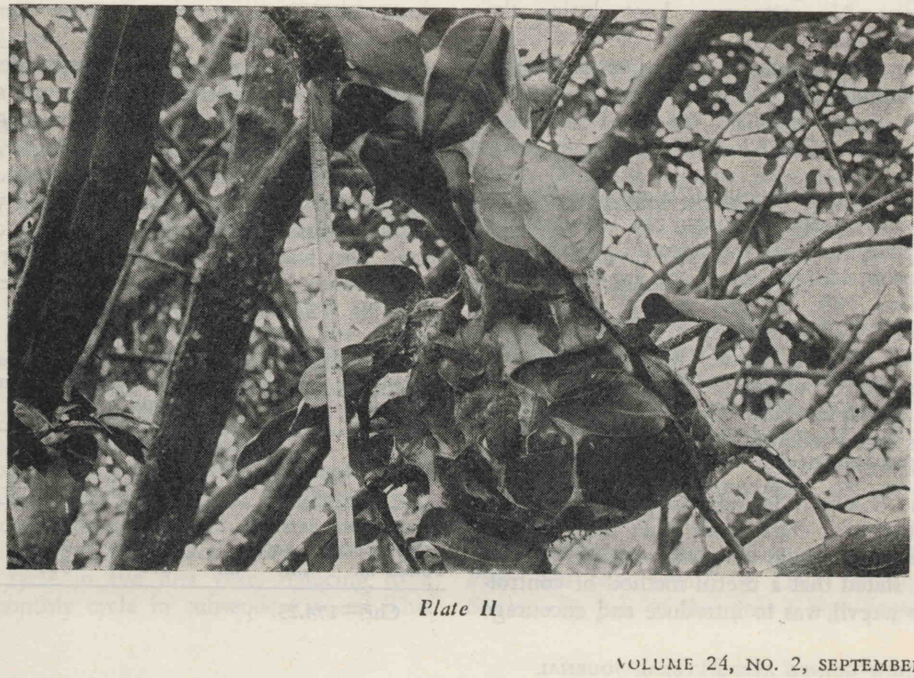

Plate II

Plate III

To reduce the number of trees occupied by, and also the total number of *Technomyrmex* foraging within the study area, the cocoa tree trunks and foliage were sprayed with a 1.3 per cent solution of dieldrin. When inspected one week later, 50 per cent of the trees were free of *T. detorquens* and the numbers foraging over the rest of the trees were very reduced.

When *Oecophylla* were again introduced two weeks after spraying colonisation was apparently successful. New nests were formed in the cocoa and the *Oecophylla* foraged freely in the surrounding trees. Some seven months after their introduction, however, the *Oecophylla* again disappeared from the plot. The dieldrin may have had some long term effect on the *Oecophylla,* but it was thought likely that factors other than competition with *Technomyrmex* were preventing their successful introduction.

One important factor which is probably influencing the introduction of *Oecophylla* intc young cocoa under *Leucaena* is the availability of food for the ants.

In the Solomons *Oecophylla* tends five species of pseudococcidae, and their honeydew forms an important part of their diet (Greenslade 1964). Other insects, especially larvae, make up the bulk of their diet.

Whilst no quantitative work on insect populations on young cocoa was carried out, it was observed that the pseudococcid population was generally very low in non-bearing cocoa, more being present when the flushes were young than when they had aged. With the onset of fruiting, the number of pseudococcids further increased. It was also noticeable that on farms where *Oecophylla* was present pesudococcid numbers were highest. Studies of such variations in natural insect populations and in particular the pseudococcids may lead to better timing of nest introduction.

Similarly studies of the environmental factors within the cocoa farm may also lead to more successful introductions. For example, Greenslade (1965) found in laboratory studies that the activity of *O. smaragdina* was directly related to the light intensity. Leston (1969) working with a related species *O. longnoda* in

Ghana found that they preferred sites with a well developed canopy and a light overhead shade. In the Solomons the densest populations of *Oecophylla* have been observed in areas of cocoa where the overhead shade was lighter than normal, such as in old coconut plantations and under poorly develped planted shade.

A simple trial to support this observation of the effect of shade density on the establishment of Oecophylla was commenced in October 1971. Ten nests were introduced into each of two plots of young cocoa under *Leucaena* planted at 8 x 8 feet (2.4 m) spacing. On one plot the *Leucaena* was thinned to 8 x 16 feet one month before the introductions were made. *Technomyrmex* were absent from both plots. By December 1971 no *Oecophylla* were to be found in the densely shaded plot although they appeared to have begun to establish new nests in November. They were still actively foraging on the lighter shaded plot. By March 1972, 14 new nests had been formed on the latter plot.

SUSCEPTIBILITY OF COCOA TYPES

From July 1969 to December 1970 *Pantorhytes* damage to a cocoa selection trial at Dala Experimental Station was observed at monthly intervals. The trial was originally planted in 1964 under thinned forest shade to compare the growth and yield of three cocoa selections with Trinitario cocoa from Keravat, New Britain. The four selections which were planted out in a Latin square with 40 trees per plot were Keravat Trinitario, a local Trinitario Selection, Amelonado and the progeny of the clone Na32.

Pantorhytes moved into the plot during mid 1968 from an adjacent heavily infested plot. The first two rows of plots were the most seriously damaged and by December 1970, 56 per cent of the trees of the two Trinitario types in these rows had been killed by the weevil compared with only 10 per cent of the Amelonado and 12.5 per cent of the progeny of Na32 (*Table* 4a).

The overall increases in mortality on the experiment from December 1968 to December 1970 are shown in *Table* 4b.

The December 1970 figures were analysed and showed that the plot to plot variation was high (CV = 66 per cent), but losses on the local Trinitario selection were significantly higher (P = 0.05) than on the Amelonado and the progeny of Na32. The difference between the Keravat Trinitario and the Amelonado just

Table **4A.—Number of trees killed by *Pantorhytes* on individual plots of four cocoa selections at Dala Malaita up to December, 1970**

					Total Row
Row 4	Na 4	A 1	KT 2	LT 13	20
Row 3	LT 8	Na 3	A 1	KT 4	16
Row 2	KT 26	LT 19	Na 4	A 3	52
Row 1	A 5	KT 19	LT 26	Na 6	56

Road 6M Wide

HEAVILY INFESTED PLOT

A = Amelonado KT = Keravat Trinitario
Na = Progeny of Na32 LT = Local Trinitario

Table **4B.—Trees killed by *Pantorhytes* from 1969 to 1970**

	Totals		Plot Means
	December 1969	December 1970	1970
Trinitario (ex Keravat)	18	51	12.8 a b
Trinitario (Local Selection)	32	66	16.5 a
Amelonado	8	10	2.5 b
Progeny of Na32	12	17	4.3 b

a b Duncan's test Means followed by the same letter are not significantly different at the 5 per cent level of probability. (SE ± 3.0)

failed to be significant at the 5 per cent level in this experiment (Rp = 10.9, actual difference 10.25).

It can be seen that there are obvious significant differences between the four selections in their susceptibility to the weevil. Almost the whole area of cocoa planted in the Solomons is Trinitario obtained originally from Keravat in New Britain, and even in badly infested farms some trees showed little or no damage by *Pantorhytes*. This evidence suggested the possibility of selection of cocoa types for low susceptibility, and possible mechanisms for resistance were therefore sought.

There is very little published evidence on resistance of cocoa trees to insect damage. Soria and Saunders (1966) suggested that resistance to the scolytin *Xyleborus ferrungineus* (F) was due to a naturally occurring endogenous substance. Schreurs (1965) reported apparent differences in susceptibility of some cocoa clones to attack by a cerambycid stem borer Glenea *lefebueri* (Guer) in West New Guinea. However, he did not suggest reasons as to why the difference occurred.

The susceptibility of timbers to some species of borer is probably influenced by the wood hardness and moisture content (M. B. Self and G. R. Watt pers. comm.). These factors were therefore investigated for the four selections listed in *Table* 4b. Blocks were cut from each of ten trees of Amelonado and the Na32 progeny, and from five trees of each of the Trinitario selections. The blocks measured approximately 8 x 2.5 x 2.5 inches. A small sample was cut (1 x 2.5 x 2.5 inches) for moisture determination and the remainder was used for a wood hardness test. This test was done by the Forestry Department and consisted essentially of dropping a steel ball from a fixed height on to the radial, tangential and end faces of the freshly cut block of wood.

The depth of penetration of the ball was then measured (Armstrong 1960).

Wood moisture content was estimated by oven drying the samples at 100° C for 24 hours.

The results (*Table* 5) did not show any significant difference between the selections.

It was then thought that the condition of the bark might influence susceptibility. As *Pantorhytes* lays its eggs in cracks in the bark, the thicker and rougher the bark the more potential egg laying sites there would be. This would lead to higher larval populations within and greater damage to the tree. Young trees with smooth bark would have fewer oviposition sites and would, therefore, be less susceptible to damage. Any tree which had naturally thin smooth bark would also be less susceptible in later years.

Ten bark samples were taken from the Trinitario, Amelonado and Na32 progeny. The roughness was scored on a scale 1 to 3, in order of increasing roughness and degree of natural cracking. Thickness was measured by using a micrometer and taking a mean of four sides of a 25 square centimetre sample. The results are shown in *Table* 6.

***Table* 5.—Wood hardness and moisture content of three cocoa types**

	Progeny of Na32	Trinitario	Amelonado
Penetration (1/1000")			
(Means of three faces)	226	232	222
Per cent Moisture	54.2	54.3	53.9

***Table* 6.—Bark thickness and roughness of three cacao types**

	F2 Na32	Trinitario	Amelonado
1. Mean thickness (mm)	4.4b	5.0a	4.3c
2. Roughness Score (Means)	1.7b	2.5a	1.5c

a, b, c, Duncan's Test. As for *Table* 5. S.E.1 ± 0.020 SE 2 ± 0.025

As can be seen there are definite differences between the three selections. The most susceptible, Trinitario has thicker and rougher bark at eight years old than the other selections. By retaining a smooth thin bark longer, a cocoa selection will support a lower population of *Pantorhytes* larvae. This in turn will lessen the burden of hand removal of larvae and adults. It will also facilitate the establishment of *Oecophylla,* as introductions can be delayed until the canopy is fully formed and the shade is thinned. The extra time could allow the build up of insect population within the cocoa and hence provide a better food supply for the ants.

CONCLUSION

At the present stage of development of the cocoa industry in the British Solomon Islands, there seems little hope for the control of *Pantorhytes* using insecticides. The techniques involved are too expensive and too sophisticated.

Control by plantation hygiene, which includes the hand removal of larvae and adults, is not successful in farms with or near heavy infestations. The results presented here suggest that the introduction of *Oecophylla smaragdina* into uncolonised farms may be a cheap and effective way of reducing weevil damage. However, further work on the environmental and biotic factors influencing the timing of the introduction, and the establishment of ant colonies is required.

Pantorhytes populations may be kept low in the early years by planting specially selected cocoa types with thin smooth bark and thereby allowing extra time for introducing *Oecophylla* and reducing the burden of hand removal of larvae and adults. Thin smooth bark should certainly be a criterion for selection among newly introduced cocoa varieties.

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REFERENCES

ANON (1961). *Pantorhytes* control in Cacao plantations. *Papua New Guin. agric. J.*, 14:48-51.

ANON (1971). Control of *Pantorhytes* weevil in Cocoa. *Harvest*, 1:35-41.

ARMSTRONG, F. H. (1960). The Strength and Properties of Timber. *Forest Products Res. Bull.*, 45:5. HMSO, London.

DUN, C. S. (1955). Economic Entomology in Papua and New Guinea 1948-1954. *Papua New Guin. agric J.*, 9:109-119.

FRIEND, D. (1970). A Report on Cocoa growing in the British Solomon Islands Protectorate. Mimeogrd Govt. Pr. Honiara, B.S.I.P.

FRIEND, D. (1972). Cocoa Agronomy Report for 1971. Ann. Rep. Dala Exp. Stn. Mimeogrd. Govt. Pr., Honiara, B.S.I.P.

KEEVIL, R. A. (1966). The Cocoa Industry British Solomon Islands Protectorate. South Pacific Commission Meeting on Cocoa Production, Honiara, May 1966. Tech. 6.

LESTON, D. (1969). Ants, Capsids and Swollen Shoot in Ghana; Interactions and the implications for pest control. *Proc. 3rd Int. Cocoa Res. Conf.* Accra. 1969 pp 205-221.

MACQUILLAN, N. J. (1964). Pantorhytes. Ent. Circ. Dept. Agric. B.S.I.P.

O'CONNOR, B. A. (1969). Exotic Plant Pests and Diseases Handbook. Pub. S.P.C. Noumea, New Caledonia.

SCHREURS, J. (1965). Investigations on the Biology and Control of *Glenea lefebueri*; a noxious longicorn beetle of Cocoa in West New Guinea. *Papua New Guin. agric. J.*, 17:129-155.

SMEE, L. (1963). Insect Pests of *Theobroma cacao* in the Territory of Papua and New Guinea, their habits and control. *Papua New Guin. agric. J.*, 16:1-19.

SORIA, V. J. AND SAUNDERS, J. L. (1966). Observations of Resistance to insects by some Cocoa varieties. *Cacao Turrialba,* XI:1-3.

SZENT-IVANY, J. J. H. (1961). Insect pests of *Theobroma cacao* in the Territory of Papua and New Guinea. *Papua New Guin. agric. J.*, 13:127-145.

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