37. Comparative efficacy of different insecticides on *rhynchophorus ferrugineus* F.

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INTRODUCTION

THE problem of controlling tissue borers in general has been one of considerable difficulties since, unlike as in the case of external feeders, the internal feeders spend the stage in their life history, at which they bring about the damage, within the tissue. In coconut, it is much more complex as the borer *Rhynchophorus ferrugineus* F. spends all the stages of its life-cycle within the palm. The problem has received attention from as early as 1906; but the attempts have mainly been directed on the mechanical and cultural aspects. Green (1906) and Hutson (1933) believed that control of the rhinoceros beetle *Oryctes rhinoceros* L. would directly lead to diminution in numbers of red palm weevil also, since the possibility of laying eggs by the weevil in wounds caused by the feeding of the beetle would thus be minimised. They advocated regular extraction of the different stages of the pest, removal of the affected tissue of the palm and treatment of healthy tissue of the excavation thus made with tar and cement plaster. Ghosh (1912) and Fletcher (1917) suggested protection of all accidental cuts and wounds of palm tissue by smearing with tar. They further recommended that badly affected palms should be cut down, split up and burnt. Copeland (1914) ruled out the possibility of the weevils depositing the eggs on sound trees and said they were laid only in such trees in which the softer tissues had already been exposed by mechanical injury or previous attack of other insects. He has recommended trapping the weevils by baits in the form of felled coconut palms in order to attract the weevils. Mud enclosures filled with water around the stems of date palm helped according to Madan Mohan Lal (1917) and Meckanna (1918) in saving the tree from the attack of red palm weevil. Leefmans (1920) considered the control measures from two aspects: preventive and remedial. As preventive steps, he laid great emphasis on protecting all

the parts of the young palms from all possible wounds. He further advocated burial of dead palm trees which are possible breeding places of the weevil to a depth of 8" in the soil. As remedial measures he suggested regular collection of weevils from the crown by expert labourers and by using cut sago palm stems as traps. Corbett (1932) summed up the detailed control measures into preventing injury including that caused by *Oryctes* and destroying all decayed and attacked palms by burning. Venkitasubban (1936) pointed out that the weevil control resolved itself mainly into keeping the trees healthy without cracks or wounds. Patel (1938) believed that if sufficient care was taken in treating the rotting crowns at a very early stage the pest is kept in check. According to Ayyar (1940) it was very difficult to save a tree into which the grubs had gained deep entry and therefore the best method would be to prevent the insect from getting access into a tree for egg laying. Some preventive and mechanical measures for controlling the pest on date palm in Punjab have been suggested recently by Ahmad and Ullah (1951).

The use of chemicals against the pest has been comparatively recent. Earlier, Copeland (1914) used carbon-bi-sulphide but with little success. Leefmans (1920) considered injection with carbon-bi-sulphide a good curative for trunk and bole attacks. Tidman (1951) found BHC, DDT and Parathion quite useless against *Rhynchophorus palmarum* in Brazil. He got some control by arsenical dusting, but to no great extent. According to recommendation of the Indian Central Coconut Committee (1956), as a prophylactic measure of control, the leaf axils of young palms should be filled with a mixture of sand and five per cent BHC dust, or sand and five per cent Chlordane dust in equal proportions. Before laying eggs the weevils rest in the leaf axils and contact with the insecticide proves fatal to them. Edgard (1956), while describing control of coconut beetles and weevils in Thailand reports poor results with injecting chemicals like cynogas etc. Spraying the young palms with 0.1% Dieldrin at an interval of three months, however, proved according to him to be effective, for controlling the pest. Nirula *et al* (1953) and Nirula (1956) tried a few modern insecticides and found 1% Pyrethrins piperonyl butoxide (Pyrocon-E) in water when injected into infested trees saved the tree provided the attack had not reached the growing point. Kurian and Antony (1957), while describing the biology, symptomatology and control measures in detail, devide the control measures into prophylactic, sanitational and remedial methods. Menon and Pandalai (1858) have reviewed the there-to-known methods of effective control.

With the availability of a good number of modern insecticides, the present investigations were undertaken at the Central Coconut

Research Station, Kayangulam, to find out if other chemicals cheaper than Pyrocon-E (which costs about 0.75 nP. to Re. 1 per injection) could effectively control the pest.

Materials and Methods

The chemicals used in the experiment were Aldrin, Dieldrin, Endrin, Diazinon, Parathion, and Pedix-bade-Emulsion, at 0.1, 0.25, and 0.5 per cent strengths. Aldrin and Dieldrin were obtained from Messrs Burmah Shell Oil Storage and Distributing Co. of India Ltd., as wettable powder at 40% and 50% strengths respectively. Aldrin contained 95% HHDN and 5% related insecticidally active chlorinated hydrocarbons. Dieldrin had 85% endo-exo isomer of HEOD and 15% related compounds of insecticidal activity. Endrin, composed of pure endo-endo HEOD was also a "Shell" chemical available at 20% strong emulsion. Diazinon, commonly known under the trade name 'Basudin' was manufactured by Messrs Geigy Insecticides Ltd., and was obtained as 20% strong emulsion. It is a phosphoric acid ester. Parathion emulsion, containing 46.6% Di ethyl paranitrophenyl thiophosphate and 53.4% special emulsifier and popularly known as Folidol-E 605 is a "Bayer" product and was supplied by Messrs Chika Ltd., Bombay at 46.6% strength. Pedix-bade emulsion was obtained from VEB Fettchemie and Fewa-Werk and contained 12% DDT and 5% Gamma-HCC in the form of a concentrated aqueous solution. The required dilutions were prepared by mixing the respective quantity of each insecticide with tap water.

The insects used in these investigations were the larvae and adults of *Rhynchophorus ferrugineus* F. Fresh larvae were selected from collections of the same from infested palms; and their size was kept as uniform as possible. Adults were the ones which newly emerged from the pupal cocoons brought from the field and kept in laboratory cages.

The trials were conducted in the laboratory in the following manner:

In the case of larvae, they were first allowed to establish themselves in the host tissue by providing cut portions of coconut leaf petiole (about 12" long), bored to a height of 3" from one end by means of an auger. One larva was introduced into each piece. 24 hours after setting like this, the petiole pieces were split open along the middle, lengthwise and the larvae taken out and dipped in the respective suspension or solution for two minutes. They were then reintroduced into the tunnels made by them after placing them on dry

blotting paper and thus drawing excess of the insecticide, if any. The two halves of the petiole pieces were fastened together. There were five grubs in each trial and each trial was replicated five times. Grubs in the control were dipped in tap water for the same period as in treatment. In the case of adults, they were dipped in the diluted insecticidal suspension or solution for two minutes and allowed to walk on dry blotting paper and then introduced into separate jars along with food in the form of fresh, cut portions of coconut leaf stalks.

Observations on normalcy, paralysis, and death were recorded after every hour up to the end of the first six hours and thereafter at intervals of 24 hours for a maximum period of seven days. A grub was considered paralysed when it refused to feed and/or showed only very feeble movements when touched gently. The paralysed adults lay on their back unable to set themselves to the normal posture.

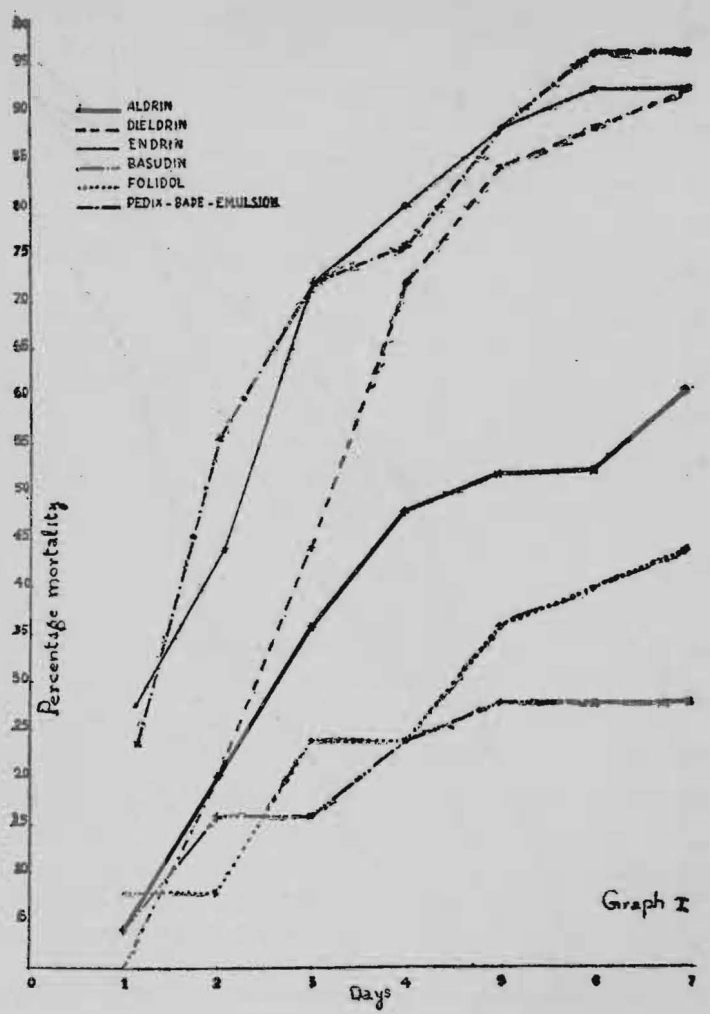
Results

Results of observations after the first 24 hours and seven days only have been given in the Tables.

(a) *against grubs*

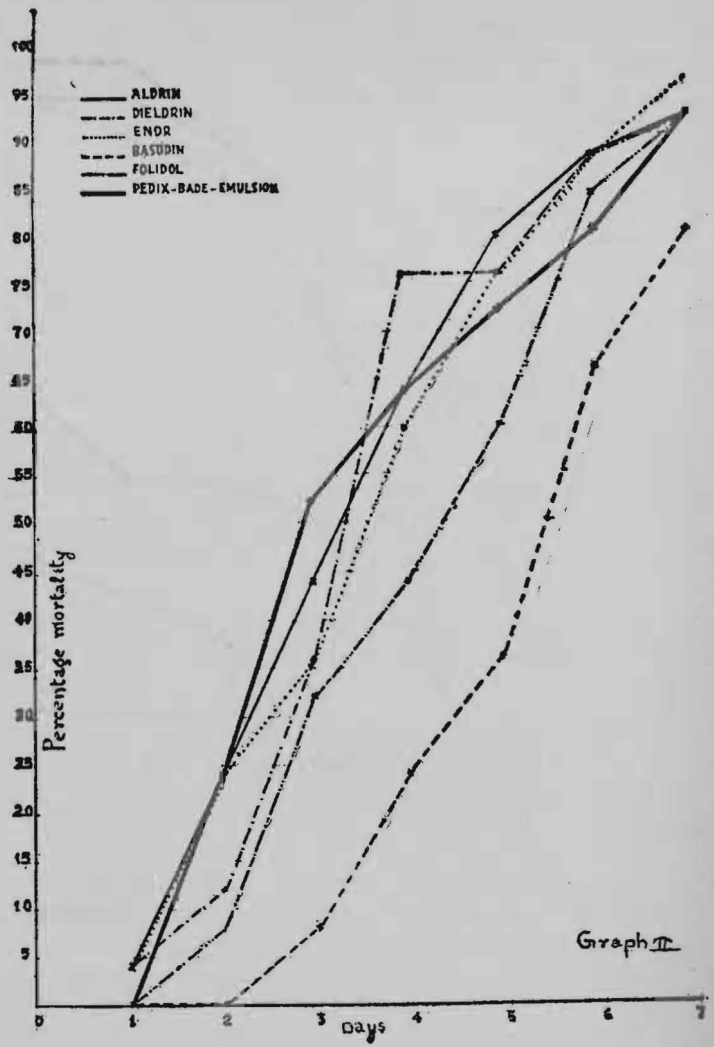
None of the insecticides at any strength had any visible effect on the larvae during the first hour. The insecticidal effect was not very encouraging for the first six hours especially at lower strengths. The quickest and the maximum knockdown occurred in the case of Endrin with a paralysis of 28% at the second hour and 86% at the sixth hour, at 0.5% strength. Dieldrin and Pedix-bade emulsion produced 4% paralysis at 0.1% after two hours and Aldrin 4% death at 0.5 per cent concentration after a period of 3 hours. The fate of grubs after 24 hours (Table 1) was different in the different insecticides. Even at 0.25%, grubs in Aldrin, Diazinon and Pedix-bade emulsion remained 100% normal, while the highest mortality was produced with Endrin at 0.5%. Endrin had produced 20% paralysis even at 0.1%. All the grubs remained normal in the control.

After 7 days (Table 1) Pedix-bade emulsion gave 96% mortality, and Endrin and Dieldrin 92% mortality at the highest strength. Diazinon was the least effective. Parathion also gave only less than fifty per cent mortality. Lowest strength did not yield encouraging results except in the case of Endrin which produced 56% mortality. 0.25% Endrin produced more than twice the mortality brought about by Aldrin and Dieldrin and thrice that by Parathion and Pedix-bade emulsion.



The increase in percentage mortality (Graph I - Table 3) with advancement in period was more steady in the case of Endrin and Pedix - bade, emulsion than in the case of other insecticides. Aldrin gave promising results till the fourth day; but thereafter lost the power to continue to effect mortality. The percentage mortality effected after seven days by Diazinon was the same as that produced at the end of the fifth day. Dieldrin had comparatively little insecticidal effect during the early period but produced 92% mortality after 7 days.

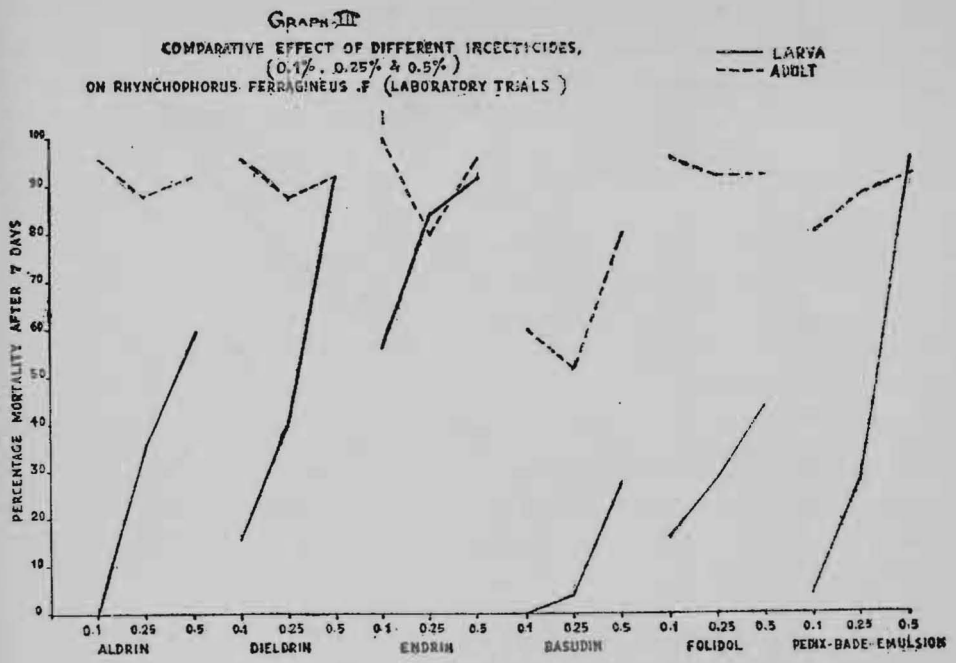
The insecticidal effect with increase in strength varied in the different cases (Graph III - Table 1). Dieldrin alone showed an increase in percentage mortality proportionate to the increase in strength of



insecticide, ratio being 1:2.5: 5 = 1:2.5: 5.75. For Pedix-bade emulsion the ratio was 1:7:24, for Folidol, 1:1.75: 2.75 and for Endrin, 1:1.5: 1.6.

(b) *against adults*

No weevil was observed seriously affected by any of the insecticides at any concentration for the first hour except that the weevils were restless. Unlike as in the case of grubs, the insecticidal effect during the first six hours was markedly pronounced. There was 84% paralysis with 0.5% Endrin after six hours. Paralysis was effected as early as after 3 hours at the lowest strength of Aldrin, Endrin, Folidol and Pedix-bade emulsion.



The percentage mortality after 24 hours (Table 2) was not very high in any case; but the paralysis was great with the result that the number of adults remaining normal was small. 100% adults were normal in control.

After 7 days 0.1% Endrin effected 100% mortality of weevil. Parathion, Dieldrin and Aldrin 96%, Pedix-bade emulsion 80%. Diazinon here again was the least effective with only 60% death.

The number of adults killed increased from day to day (Table 3 - Graph II). There was no mortality for the first day by Diazinon, Parathion and Pedix-bade emulsion. Highest percentage mortality (96) at 0.5% strength was effected by Endrin after 7 days. It was 92 for Aldrin, Dieldrin, Parathion and Pedix-bade emulsion. Diazinon produced only eighty per cent.

The results obtained with increased concentrations of insecticides were anomalous. Except in Diazinon and Pedix-bade emulsion, the number of grubs killed at higher strengths was smaller than those killed at lesser strengths.

Discussion

The behaviour of the weevils and larvae during the first twenty-four hours is of importance in evaluating the knockdown capacity of

the insecticide. As already mentioned Endrin gave the quickest and the maximum knockdown. It is also noteworthy that none of the grubs and adults once knocked down by the insecticides regained normalcy, but succumbed. An insecticide is valued not only for its immediate knockdown capacity but also for its residual toxicity. Analysis of the results shows that the different insecticides continued to increasingly effect paralysis and mortality till the fourth day. Fresh paralysis effected after the fourth day was comparatively at a lesser rate than that of the earlier period as shown by the decrease in the number of normal insects. 4-8% of paralysed larvae remained as such without being killed after the 7th day. Of the six insecticides tried, Endrin yielded the best results at 0.5% for grubs and 0.1% for adults.

The effect of the insecticides, it is to be pointed out, was different for grubs and adults. Whereas 0.5% concentrations was required for the highest percentage mortality of grubs the lowest strength of 0.1% was sufficient to cause equal, in some cases even more mortality in the case of adults. It is possible that moulting may free the grubs of the insecticidal effect in the case of contact insecticides since during the process of moulting, the skin which had come in contact with the lethal dose of poison is discarded. It is common observation that larvae soon after moulting with a soft outer covering sooner succumbs to insecticidal action. The adults which have reached the last stage in their life history are probably subjected to both contact and fumigant action of the insecticides in spite of a hard and chitinised exoskeleton. It is also to be presumed that, since freshly emerged adults were selected for the investigations, sufficient time was not allowed for hardening of the exoskeleton before subjecting them to the trials.

Certain anomalies have been noticed in the results. The most striking one is the fall in percentage mortality of adults with the increase in concentration of the insecticide (Graph III, Table 2). Whereas 100% mortality was effected by Endrin at 0.1%, it was only 80% at 0.25% and 96% at 0.5%. Pedix-bade-emulsion alone showed an ascending graph. Diazinon caused the greatest mortality at the highest strength. All other four insecticides showed lesser mortality at higher strengths than at the lowest. This cannot be ignored or accounted for as experimental error. Other workers (unpublished work) have also taken note of this phenomenon in the case of insecticides with *Nephantis serinopa* larvae and *Oryctes rhinoceros* grubs; in both these cases, however, the insecticides tried acted as stomach poison mainly. This, the authors feel, deserves further investigations.

The results obtained for Pedix-bade emulsion are much different from what Nirula (1956) found for DDT on the same pest. Of the five

insecticides tested by him DDT gave the poorest results both for adults and larvae. 1% DDT produced 26% mortality for grubs and 16% mortality for adults, after 7 days. Presumably, the combination of 5% Gamma-HCC with DDT has been responsible for the enhanced insecticidal effect.

Summary

1. The earlier methods of control have been directed mainly on the mechanical and cultural aspects. Chemical control of the palm weevil has only been recently attempted.

2. Aldrin, Dieldrin, Endrin, Basudin, Folidol and Pedix-bade emulsion were tried against the larvae and adults of *R. ferrugineus* F. at 0.1%, 0.25% and 0.5% strengths in the laboratory.

3. Endrin gave the best results with 92% mortality of grubs at 0.5% and 100% mortality of adults at 0.1%.

4. Percentage mortality was greater for adults than for grubs at the same concentration.

5. Increase in strength did not show a corresponding increase in mortality for adults. The results, on the other hand, were anomalous. For grubs, a corresponding ratio was kept up by Dieldrin.

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Table 1

Showing fate of Grubs of Rhynchophorus ferrugineus F. 24 hours and 7 days after being treated with different insecticides at 0.1; 0.25 and 0.5% strengths – average results of five replications

Period	After 24 hours									After 7 days								
Strength %	0.1			0.25			0.5			0.1			0.25			0.5		
No. Treatment %	N	P	D	N	P	D	N	P	D	N	P	D	N	P	D	N	P	D
1. Aldrin	100	—	—	100	—	—	52	44	4	100	—	—	64	—	36	32	8	60
2. Dieldrin	88	8	4	88	12	—	48	52	—	84	—	16	56	4	40	4	4	92
3. Endrin	76	20	4	56	24	20	8	64	28	44	—	56	12	4	84	—	8	92
4. Diazinon	100	—	—	100	—	—	84	12	4	96	4	—	92	4	4	64	8	28
5. Parathion	100	—	—	88	12	—	88	4	8	84	—	16	72	—	28	52	4	44
6. edix-bade emulsion	96	4	—	100	—	—	16	80	4	96	—	4	72	—	28	—	4	96
7. Control	100	—	—	100	—	—	100	—	—	96	—	4	100	—	—	80	4	16

TABLE 2

Showing fate of Adults of Rhynchophorus ferugineus F. 24 hours and 7 days after being treated with different inseeticides at 0.1, 0.25 and 0.5% strengths – average results of 5 replications

Period		After 24 hours									After 7 days								
Strength %		0.1			0.25			0.5			0.1			0.25			0 5		
No.	Treatment %	N	P	D	N	P	D	N	P	D	N	P	D	N	P	D	N	P	D
1.	Aldrin	24	64	12	36	64	—	4	92	4	—	4	96	—	12	88	—	8	92
2.	Dieldrin	44	52	4	32	64	4	16	80	4	—	4	96	—	12	88	—	8	92
3.	Endrin	16	80	4	4	96	—	—	96	4	—	—	100	—	20	80	—	4	96
4.	Diazinon	88	8	4	88	8	4	88	12	—	18	12	60	28	20	52	20	0	80
5.	Parathion	12	68	20	20	72	8	16	84	—	4	—	96	4	4	92	—	8	92
6.	Pedix-bade emulsion	60	32	8	28	72	—	8	92	—	16	4	80	8	4	88	—	8	92
7.	Control	100	—	—	100	—	—	100	—	—	80	4	16	100	—	—	96	—	4

TABLE 3

Showing comparative effect of insecticides at 0.5% strength on grubs and adults of Rhynchophorus ferrugineus F. during different periods of contact – average results – % mortality of five replications

			GRUBS							ADULTS						
No.	Treatment	Days	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1.	Aldrin		4	20	36	48	52	52	60	4	24	44	64	80	88	92
2.	Dieldrin		0	20	44	72	84	88	92	+	12	36	76	76	88	92
3.	Endrin		28	44	72	80	88	92	92	4	24	36	60	76	88	96
4.	Diazinon		4	16	16	24	28	28	28	0	0	8	24	36	66	80
5.	Parathion		8	8	24	24	36	40	44	0	8	32	44	60	84	92
6.	Pedix-bade emulsion		24	56	72	76	88	96	96	0	24	52	64	72	80	92
7.	Control		—	—	—	—	—	—	—	—	—	—	—	—	—	—

N = Normal
P = Paralysed
D = Dead

REFERENCES

* Ahmad, M. N. and Ullah, M. H., (1951) Date cultivation in Punjab. *Punjab Fruit J.*, January-April, 1951.

Ayyar T. V. R., (1940) *Hand-book of economic entomology for South India.* Govt. Press, Madras.

Copeland, E. B. (1914) *The Coconut*, Mac Millan & Co., London.

Corbet, G. H., (1932) Insects of coconuts in Malaya, Dept. *Agr. S. S. & F. M. S. General series Bulletin* No. 10.

Edgard, F. V., (1958) *FAO Plant Protection Bulletin*, Vol, V, No. 3.

Fletcher, T. B., (1914) *Some South Indian Insects.* Govt. Press, Madras.

* Ghozh, C. C., (1912) The rhinoceros beetle and red or palm weevil. *Mem. Dept. Agr. India* II.

* Ibid, (1923) *Oryctes rhinoceros* and other important pests in Burma. *Proc. v. ent. mtg., Pusa.*

* Green, E. E., (1906) Rhynchophorus ferrugineus. *Trop. Agriculturist*, Vol. xxvii.

* Hutson, J. C., (1933) The red weevil of coconut, *Dept. Agr. Ceylon*, leaflet No. 22 (revised).

Kurian, C. and Antony, J., (1957) The enemy that strikes to kill. *Coconut Bulletin*, August, 1957.

+ Leefmans, S., (1920) De Palmsnuitkever *Rhynchophorus ferrugineus* Oliv. *Mededeelingen van het Instituut voor Plantenziekten.* No. 43.

* Madan Mohan Lal, (1917) Rept. Asst. Prof. Entomology. *Rept. Dept. Agr. Punjab* for year ended 30th June 1917.

* Meckanna, J., (1918) *Rept. on the progress of agriculture in India for the year 1916-17.* Govt, Press, Calcutta.

Menon, K. P. V. and Pandalai, K. M., (1958) *The Coconut Palm - A Monograph* Indian Central Coconut Committee, Ernakulam.

Nirula, K. K., Antony, J. and Menon, K. P. V., (1953) The red palm weevil and its control. *Proc. 40th Ind. Sci. Congress.*

Nirula, K. K., (1956) Investigations on the pests of coconut palm. Part IV. *Rhynchophorus ferrugineus* F. *Indian Coconut J.* **10**, (1).

Patel, J. S., (1938) *The Coconut - A Monograph*, Govt. Press, Madras.

Tidman, D. A., (1951) Some agricultural and horticultural problems in Brazil. *Plant Protection Overseas Review*, 2, (1).

Venkitasubban, C. S., (1936) Pests of coconut palm. *Dept. Agr. Ent. Ser. Bull. Cochin.*

Venkitasubban, C. S., (1956) Coconut cultivation and control of pests and diseases, *Coconut Bulletin*, **10**, (3).

* Originals not consulted by the authors.

\+ Seen only the summary.