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BIOLOGICAL SUPPRESSION OF COCONUT RHINOCEROS BEETLE *ORYCTES RHINOCEROS* (L.) IN MINICOY, LAKSHADWEEP BY *ORYCTES* BACULOVIRUS – IMPACT ON PEST POPULATION AND DAMAGE*

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ABSTRACT

The population of *Oryctes rhinoceros* (L.), one of the key pests of coconut palm, has been substantially reduced in Minicoy Island, Lakshadweep, through the use of a virus disease of the pest. *O. rhinoceros* beetles were infected with *Oryctes* baculovirus ($\simeq$30 LD_{50} dose/ml. of inoculum) and released into the pest population in Minicoy Island in April, 1983. The virus was previously isolated from field-collected, diseased *O. rhinoceros* beetles from Kayangulam in Alleppey District, Kerala. Pre-release observations at Minicoy in April, 1983 revealed high incidence of pest damage to coconut and the absence of the viral disease in the pest population. Post-release observations recorded after two years revealed spread of the virus disease to the subsequent generations of beetles and larvae in breeding sites. The resultant epizootic in the pest population drastically reduced the larval population in breeding sites, leading to a substantial reduction in the damage to coconut palms in experimental plots.

INTRODUCTION

Oryctes baculovirus, a viral pathogen of the coconut rhinoceros beetle, *Oryctes rhinoceros* (L.) has been successfully used to suppress the pest population of *O. rhinoceros* in the South Pacific Islands, Fiji, Mauritius, Seychelles and Papua New Guinea (Marschall, 1970; Hammes, 1971; Young, 1974; Bedford, 1977; Gorick, 1980). Wherever the virus was introduced into the habitat of the pest, an initial epizootic decimated the larval and beetle populations resulting in drastic reduction in crop damage. The easy and rapid transmission of the virus disease could maintain the pest at low levels for many years in some islands. Young and Longworth (1981) reported the successful control of *O. rhinoceros* by baculovirus in Tonga for seven years after its first and only release in 1970, whereas in Western Samoa, a resurgence of the pest was noticed at low levels of virus incidence, four years after the viral epizootic. Subsequent re-release of a small number of diseased beetles brought about substantial reduction in pest population and crop damage (Marschall and Ioane, 1982). Taking into account both the extremes, an ideal schedule should include minimum three spaced releases of virus-infected beetles. The experiences of successful biological

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control of *O. rhinoceros* unambiguously points to the potential of the virus (Malaysian isolate) for long-term control of the coconut pest in island habitats.

In addition to Malayasia, where the virus was first discovered by Huger (1966) it has been reported to occur in the wild populations of the pest in the Philippines, Indonesia and India (Zelazny, 1977b; Mohan *et al.* 1983). This paper describes the biological suppression of *O. rhinoceros* by *Oryctes* baculovirus (Kerala isolate) in the island of Minicoy, Lakshadweep.

MATERIALS AND METHODS

a) *Screening of beetles and larvae in Minicoy*: Prior to the release of virus - infected beetles it was necessary to screen the wild pest population for the incidence of baculovirus disease. Accordingly, one hundred *O. rhinoceros* beetles were collected from the crowns of infested palms and breeding sites (fallen coconut trunks, decaying coconut stumps etc.) from all over the Island, and screened for symptoms of baculovirus disease by (1) visual examination of midgut and its contents, (2) Giemsa stained smear of midgut cells, (3) immuno-osmophoresis of the midgut aspirate (Zelazny 1978; Mohan *et al.* 1983). An equal number of breeding sites were raked up and three grubs collected from each site were kept in a box, containing organic matter from the same site, and observed in the laboratory for two weeks, for the appearance of symptoms of baculovirus disease.

b) *Experimental fields*: Fig. 1 depicts the map of Minicoy Island. The farm of the Central Plantation Crops Research Institute (CPCRI) of area of 6 ha almost in the centre of the Island, was one of the experimental plots. Eight hundred coconut palms falling in the age

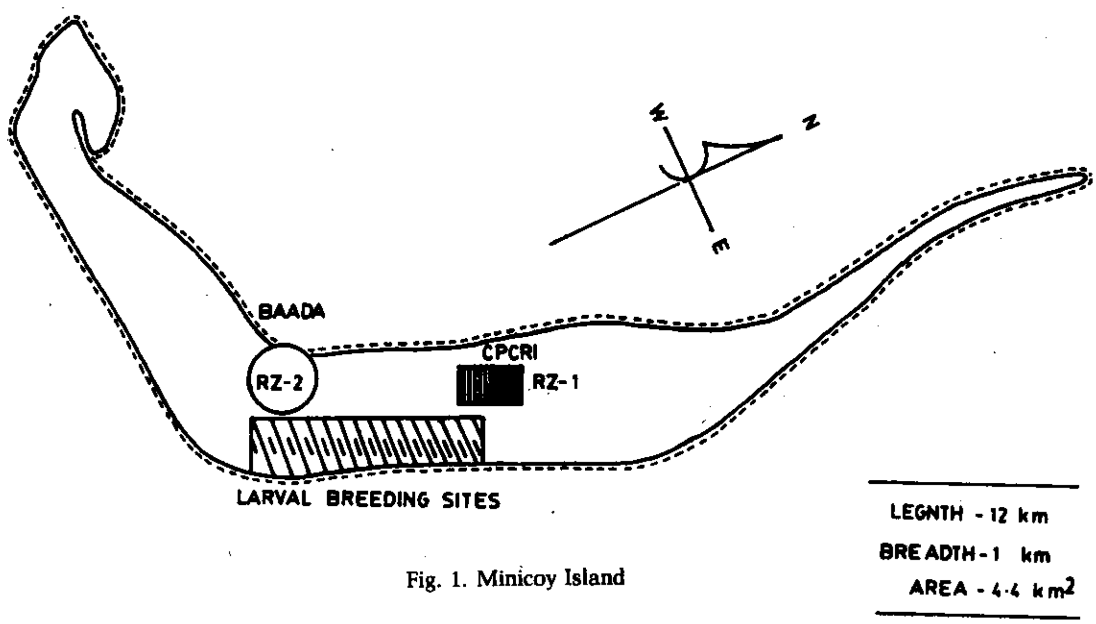

Fig. 1. Minicoy Island

group fo 5-50 years were taken and among them 80 palms (10% sample size) were randomly picked for detailed observations relating to the condition of the opened leaves, spathes and spindles. The CPCRI plot also constituted the first Release Zone (RZ-1) since virus-infected *O. rhinoceros* beetles were first released here. The second experimental plot constituted village lands of Baada, Rammid I and II, Boduvathiri, Side-waloo, Ahamuge, Phunhilol and RBBS (Radio Broadcasting and Ranging Station) on the south-western part of the Island. The second release of diseased beetles was made in Baada plot (RZ-2), about 3 Km from RZ-1. The number of palms taken up for the study was 420 in Baada and adjoining plots, 460 in Ahamuge and adjoining plots and 170 in the RBRS plot. The sample palms for detailed observations consisted of 10% of the above number. Capture of beetles was recorded in all palms, whereas the condition of every opened leaf (damaged/healthy), spathe and the central spindle of only sample palms was recorded. The percentage of pest damage was calculated by computing the proportion of damaged leaves/spathes to the total leaves/spathes which had emerged since the last observation. The data were analysed by randomised block design.

For studying the impact of the virus disease on the population level of beetles/larvae, an experimental plot was chosen on the south-eastern part of the Island of area approximately 80 ha (~0.9 Km^2) consisting of the lands of villages of Allody, Funhilol and Pallissery. The area contained maximum density of breeding sites of the pest in the form of rotting coconut stumps and fallen logs. The area was divided into five zones for the convenience of enumeration of breeding sites and the larvae within. The following observations were recorded per site: i) No. of larvae (instar wise), pupae and live beetles (ii) Cadavers of larvae and beetles. Only sites considered suitable for the breeding of *O. rhinoceros* were raked up for taking observations and the larvae were put back into the sites after enumeration. If there was a wide variation between the larval stages within a single site, it was presumed to have come from more than one brood. A breeding site was deemed to contain infective virus if morbid larvae with striking external symptoms of virus disease were found or if the samples larvae developed the disease in the laboratory, later on.

c) *Method of infection and release:* Field-collected *O. rhinoceros* beetles were allowed to wade through virus inoculum contained in a basin for 30 min. The inoculum contained 1 g of infected larval tissue in 1 l of phosphate buffer (0.05 M, pH 8.0) which amounted to 31.6 LD 50 dose and 3% sucrose. After the swim treatment the beetles were confined together in a box containing rotting coconut wood powder mixed with virus inoculum, used before for 24 h. The treated beetles were removed the following day and confined in a box with fresh coconut petiole pieces as feed for a week, since infected beetles begin excreting baculovirus only after a week post-infection. The beetles were liberated after dusk in the experimental plots.

RESULTS

Pre-release screening of approximately one hundred beetles and an equal number of larval breeding sites from all over the Island in January and April, 1983, revealed the total absence of the virus disease.

Detailed observations of palms in experimental plots recorded before the introduction of virus disease showed high incidence of leaf (60%), spathe (30%) in CPCRI farm and plots of Ahamuge Village in 10% of the palms examined.

The release of 130 infected *O. rhinoceros* beetles in April, 1983 in the CPCRI farm resulted in a significant reduction in crop damage (Fig. 2) in all the four experimental plots. There was a steady decline in the leaf damage with time in all the plots consequent to the introduction of the virus disease, excepting in Baada. The means (leaf damage) of the four plots showed significant differences between the observations at different times (Table I). The leaf and spindle damage at Baada did not decline till Jan. '84 viz., ten months after the introduction of the virus disease, but did so subsequently. This is the site of the second release of 35 infected beetles in Jan. 1984.

The reduction in spathe damage in the four plots described a steeper concerted decline and the mean values were significantly diffeent between observations, excepting the last two in November '84 and September '85 since the values had reached the lowest levels in November '84 itself. Again the rate of decline of spathe damage in Baada was much slower as compared to that in CPCRI and Ahamuge. The reduction in spindle damage was also drastic in all barring Baada. Spindle damage reached its nadir

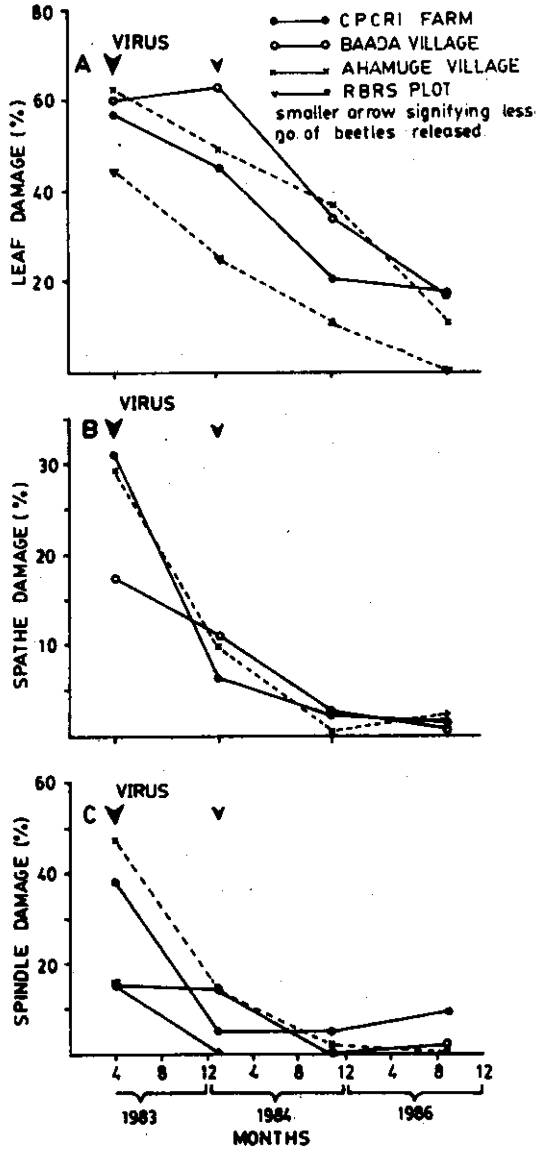

Fig. 2. Effect of the release of Baculovirus - infected *O.rhinoceros* beetles on damage to leaves (A), spathes (B) and spindles (C) in the experimental plots in Minicoy

in CPCRI soon after the introduction of the virus disease and thereafter remained stabilised at low levels around 5%. The

Table I. *Impact of the introduction of baculovirus disease into* O. rhinoceros *population in Minicoy, on crop damage in experimental plots*

	Means (%) of experimental plots		
	Leaf damage	Spathe damage	Spindle damage
Pre-release:			
April, '83	55.83	25.90	29.56
	(46.66)d	(30.75)c	(32.62)b
Post-release:			
January '84	45.43	8.86	8.27
	(42.52)c	(17.73)b	(15.61)a
November '84	25.57	1.95	1.84
	(30.18)b	(8.84)a	(7.85)a
September '85	12.89	1.61	2.90
	(20.26)a	(8.27)a	(9.01)a

(Figures in parentheses denote angular transformed values)

C.D (5%)	5.40	6.14	9.72
C.V. (%)	9.36	16.73	31.32
SEM	1.75	1.88	3.16

Means in the same column with letters in common are not significantly different.

mean spindle damage values after January '84 were not significantly different at 5% level, nevertheless they are significantly different from the pre-release observations in April, '83.

In brief, the mean reductions in leaf damage after 9, 19 and 29 months after the release of virus-infected beetles were 18.63, 54.20 and 76.91%, respectively. Similarly, the mean reductions in spathe and spindle damage during the same time intervals were 65.79, 72.02, 92.47, 93.77, 93.78 and 90.19% respectively.

The virus disease seemed to have a marked effect on the larval population in breeding sites. Immediately after the introduction of the virus disease in April

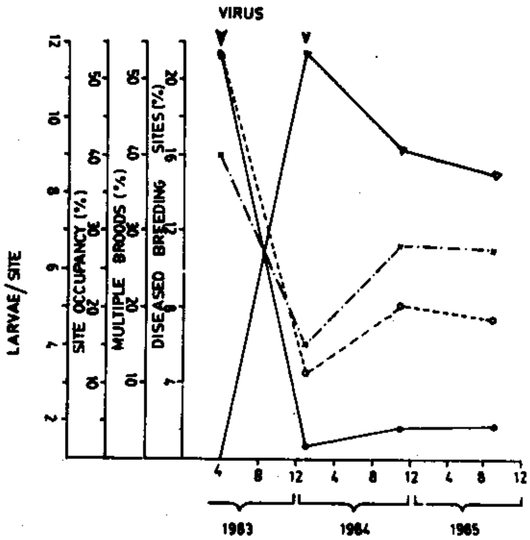

Fig. 3. Effect of the Release of Baculovirus - infected *O.rhinoceros* beetles on larval populsation in breeding sites in minicoy

Larval population •—•; Site occupancy ——; Breeding sites with diseased larvae ▲—▲; Incidence of multiple broods o--o;

'83 a steep decline was recorded in the larval population in breeding sites (Fig. 3) and the associated site occupancy percentage (SOP) which is the ratio of breeding sites in the experimental plots occupied by larval stages to the total sites screened.

Thereafter the larval population was maintained at a low level due to the suppressive effect of the virus disease albeit a small increase after the initial epizootic. SOP almost followed a similar trend to that of the larval population and showed an increase in November '84 in spite of the release of a small number of virus infected beetles (35) in January '84. Similarly the percentage of sites containing one brood also drastically declined establishing a relationship between incidence of multiple broods and virus disease transmission. On the same count the % of breeding sites which diseased larvae rose sharply to 22.

DISCUSSION

The absence of baculovirus disease in the natural population of *O. rhinoceros* in Minicoy coupled with the medium to high incidence of pest damage to coconut palms prompted us to test the efficacy of the Indian isolate of *Oryctes* baculovirus in Minicoy, Lakshadweep.

The foremost inference which could be drawn was that the virus-infected beetles released from CPCRI farm in Arpil '83 had transmitted the disease to the next or even second generation beetles and to larvae in breeding sites within a span of nine months (January '84). The mode of transmission of *Oryctes* baculovirus disease in nature has been worked out based on the trials which the Malaysian isolate of *Oryctes* baculovirus in the South Pacific Island (Zelazny, 1976). The rapid spread of the virus disease in Minicoy had presumably triggered an epizootic resulting in the crash of larval population in breeding sites (Fig. 3) and free flying adults (data not presented) and culminated in the reduction of crop damage by pest in all the experimental plots. Past experience with the field trials of *Oryctes* baculovirus in South Pacific Island and other places also indicates rapid spread of the virus disease causing epizootics and improvement in the condition of palms (Bedford, 1980).

The reduction in leaf damage consequent to the release of virus-infected beetles had been much slower (but statistically significant) as compared to the rapid decline in spathe and spindle damage. This could be due to the fact that in a coconut palm, damage to the fronds in generally the heaviest as compared to spathes (which are also few in number) and the spindle leaf. Hence, any reduction in the pest population is reflected by a sharp drop in spathe damage (being few in number) as against a slow decline, in reduction of leaf damage due to the gradual replacement of damaged leaves by healthy.

The slower response of palms in Baada plot in reflecting the reduction in pest population could be due to its close proximity to the area of maximum density of breeding sites on the south-eastern side of the plot. Hence the nearness to innumerable breeding sites kept up the supply of beetles from sites not affected by disease and thus leaf and spindle damage in Baada did not decline till January '84 in the face of the initial epizootic. Subsequently as these 'escaped' breeding sites also became infected, the beetle population in Baada declined leading to the improvement in the conditions of palms from January '84 onwards.

It may be noted that there was a fall in spathe damage (mean) by 65.8 and 92.5% in 9 and 19 months time respectively after the introduction of the virus disease, since spathe damage is economically the most serious.

The first direct evidence of the transmission of baculovirus disease in Minicoy was the dramatic fall in the larval population in breeding sites and SOP. Young and Longworth (1981) reported a reduction in larval population (Larvae/site) by $\simeq$43% soon after the first virus epizootic in Tonga and remarkably the reduction was found to be 47% after another seven years with no further release of virus infected beetles whereas the reduction in larvae/site in Minicoy after the epizootic was by $\simeq$ 94% and a level of 86% was maintained thereafter. Moreover the number of breeding sites examined in Minicoy was 720, as against 69 by Young and Longworth (1981). A strong negative correlation is evident between the incidence of multiplebroods and disease in breeding sites, an observation corroborated by Zelazny (1976), since high incidence of multiple broods in a site increases the probability of virus contamination of the site by visiting females. The incidence of disease in breeding sites would probably be maintained around 15% and thus is on par with the level of 9.3% recorded in Philippines (Zelazny, 1977b), 7.3 to 8.4% in Western Samoa (Zelazny, 1977a).

Areas having high density of breeding sites are expected to have low incidence of disease due to the reduced chances of multiple visits by beetles to the same site, hence the disease incidence observed in the 80 ha experimental plot of Minicoy (high density of breeding sites) could possibly be the lower limit.

Taking on overview of the experiment, the introduction of the Kerala isolate of *Oryctes* baculovirus disease into Minicoy to effect biological suppression of *O. rhinoceros* seems to have been achieved, though the long-term suppression has to be studied. This also seems to be on par with the South Pacific trials with the Malaysian isolate of *Oryctes* baculovirus.

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