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Introducing *Baculovirus oryctes* Huger into *Oryctes monoceros* Oliv. populations in Tanzania

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Abstract: A follow-up of a *Baculovirus oryctes* release into the population of *Oryctes monoceros* in coconut plantations in Tanzania has been made to clarify important points which were not fully considered in an earlier publication. The low recovery of virus-infected field-collected beetles (29%) suggested that the release of *B. oryctes* virus was not a suitable method for the control of *O. monoceros*. The relatively dry conditions in the coconut growing areas were partly contributory since the virus is non-occluded. No significant and sustainable reduction in frond damage was obtained after the virus had established itself in the natural *O. monoceros* population. The status of *O. monoceros* as a serious pest of coconut is also revised since the beetle affects young plantations more than older plantations and control methods can be directed at picking up feeding insects by hooking and disposal of breeding sites.

1 Introduction

Three species of palm-damaging scarabaeid beetles, *Oryctes monoceros* Oliv., *Oryctes boas* F., and *Oryctes gigas* Laporte de Castelneau are widely distributed in Tanzania, *O. monoceros* being the only serious pest of coconut palms. The pest damages new fronds by chewing a hole from the leaf axils, first horizontally into the spear and then vertically down towards the meristematic tissue. The emerging fronds are damaged in characteristic V-shaped cuts. These pests occur in all coconut growing areas of mainland Tanzania and the islands of Zanzibar, Pemba and Mafia. They are also found in regions with wild or doum palms (*Hyphaene coriacea*) and borassus palms (*Borassus aethiopum*). Whereas young palms may be killed by the repeated attacks of the pest, older coconut palms often tolerate the attack but nut production may be affected due to the reduction of leaf area and premature nut fall which may occur (Zelazny, 1977).

The removal of feeding adults from young palms by hooking is a widely used practice for control of the pest. Removal and destruction of breeding sites which are in dead coconut logs is a recommended cultural practice, although it is both difficult and labour-intensive.

A virus, *Baculovirus oryctes* (Huger) discovered in Malaysia in the Indian Rhinoceros Beetle, *Oryctes rhinoceros*, was successfully released against that species in many parts of south-east Asia and the Pacific Islands (reviewed by Bedford, 1980). Lomer (1983) and Paul (1985) found that the virus was also pathogenic to *O. monoceros* in the Seychelles and Tanzania. Extensive research in Tanzania showed that the virus was transmitted among adults through copulation and from adults to larvae and vice versa through contaminated medium. Many isolates from the Philippines, Samoa, and the Seychelles were tested in the laboratory and infection rates between 20 and 90% were found (Paul, 1985).

A pilot programme to release *B. oryctes* was initiated in 1980 at two localities, Vuo-Gezani area in the Tanga region and Magawa in the Coast region. This paper is a follow up of work presented in an earlier report (Purrini, 1988) on the selection of a suitable virus isolate for the release programme and the effect of the release on *Oryctes* population and damage to coconuts.

2 Material and methods

2.1 Testing of isolates for release

Isolates from West Samoa (SV), the Philippines (PV) and the Seychelles (SeyV) were tested in single and mixed infection trials. The methods for inoculation and evaluation were according to Paul (1985) and Purrini (1988).

2.2 The release programme

For the pilot field release, the Vuo-Gezani area north of Tanga with a high density of coconut palms and an *Oryctes*-damage level in the range of 30–45% was selected. The insect material for this release was obtained by mass rearing of third instar larvae and field collection of adults from breeding sites at Pangani and Stahabu.

Magawa area, 100 km south of Dar es Salaam and with between 55 and 66% frond damage, was selected as the second area for the test release in the Coast region, because lethal disease had killed thousands of palms whose logs offered abundant breeding sites for the beetles. Insect material for this release was field-collected adults from breeding sites in the Coast region. Only young adults (2–3-week-old) were used. Age could be estimated from the light colour of the elytra, few signs of wearing and scratching on the elytra and thorax and the presence of full tarsal segments. Some of the beetles were collected from their pupal chambers.

The release at Magawa was made at four sites along a footpath of about 7 km in the heart of a plantation of old East African Tall palms. In the Vuo-Gezani area the inoculated beetles were released along the road to Mombasa at the villages of Magaoni, Kwasongoro, Bajo and Pitukiza. (Purrini,

Table 1. *Release sites in Vuo-Gezani area, date of release, number of beetles released,* Baculovirus oryctes *strain used for infection and infection rates of control beetles*

Release areas		No. of inoculated beetles released		No. of released beetles inoculated with virus isolates		No. of control beetles inoculated with virus isolated		Infection rate of beetle retained as control	
	Dates	Female	Male	PV	PV + SV	PV	PV + SV	PV	PV + SV
Magaoni	6/6/85	60	90	75	75	25	25	60	100
Kwasongoro	22/6/85	125	125	125	125	25	25	68	100
Bajo	13/7/85	90	90	0	180	0	63	0	90.5
Pitukiza	23/7/85	100	120	0	220	0	50	0	100

Table 2. *Release sites in Magawa, date of release, number of beetles released and infection rates of control beetles*

Sites	Dates	No. of released beetles		No. of beetles retained as control	% infection of controls
		females	males		
I	9/10/85	125	174	50	80
II	19/10/85	100	200	50	80
III	26/01/86	70	130	50	86
IV	3/03/86	58	162	45	91

1988). As the rate of infection for single-isolate was low (20% for SV, and 60% for PV), different combinations of isolates were tested. The combination PV + SV proved to be the most infective with infection rates between 80 and 100%. Therefore this mixture of isolates was used for all releases except in the two initial releases at the Vuo-Gezani area in which single isolates of PV and SV were used. The virus suspension in a 10% sugar solution was fed to the beetles by a micropipette. Each beetle was given 0.01 ml of 10^{-4} g of finely ground virus-diseased midgut tissue as a standard dose. The inoculated beetles were marked on the head with a white mark, varying according to the site of release to facilitate an estimation of their dispersal. After the inoculation they were kept in basins with a mixture of cow-dung and rotten kapok wood.

In the first release the beetles were brought to the field in basins with medium. It was noticed that freeing the beetles from the medium into empty basins enhanced flight and this was the method employed in all subsequent releases. The releases were started at 1930 h and most of the beetles had flown by 2200 h. Any beetles which had not flown away by 2330 h were hand released. A group of control beetles for each release was kept in the laboratory for 3 to 4 weeks and then diagnosed for virus symptoms.

In total 800 inoculated adult beetles were released at four dates and four sites in Vuo-Gezani (table 1) and 1019 in Magawa area (table 2). From the samples retained in the laboratory as controls, it can be calculated that approximately 713 and 851 of the released beetles at Vuo-Gezani and Magawa, respectively, were infected with the virus.

2.3 Monitoring of establishment of virus

This was accomplished by trapping beetles in 120 attractant traps (Bedford, 1973), placed in each of the release sites. In the control (non-released) areas Muheza and Mwambani 40 and 90 km, respectively, from Vuo-Gezani (about 2000 ha) in Tanga region and Sotele and Chambezi about 45 and 150 km, respectively, from Magawa (about 500 ha) in the Coast region, only 30 traps were installed per area. The distance between the traps was approximately 300 m. The traps were emptied once a week and at each collection 0.4 ml of the attractant Ethyl Chrysanthemumate was applied to the lid of the traps. Post-virus beetle trapping began 1 month after the last release of virus-infected beetles. Other beetles were collected at irregular intervals from breeding sites. Since this activity affects the population of the beetles directly (collection of adults and larvae) and indirectly (destruction of suitable breeding places), only limited numbers could be collected.

2.4 Virus diagnosis

Dissection and diagnosis was according to Zelazny (1978) modified by Paul (1979).

2.5 Damage surveys

Estimation of the effect of the virus on the damage done by *O. monoceros*, was carried out in each of the released and control areas every 6 months using 'Rapid Damage Survey' (Fao, 1978). The method gives the percentage of central fronds attacked by the pest in the last 6 months.

3 Results

3.1 Post-release monitoring

The number of beetles collected in traps from 1985 to 1988 are given in table 3. Many traps were destroyed by falling leaves and nuts and by children. Therefore the variation in the numbers of beetles caught is rather a result of the fluctuating numbers of operational traps than of the population of beetles.

The male to female sex ratio (table 3) for all sites and years was 0.9. In the control areas the ratio varied between 0.6 and 1.0 and in the virus release areas between 0.9 and 1.1. No significant difference in the ratio prior to and after the release could be detected.

3.2 Infection-rates of trap and field-collected beetles

Beetles showing virus symptoms were first collected 3 to 4 months after release of *B. oryctes*-infected insects. The percentage of beetles from traps detected with

Table 3. *Number and sex of* Oryctes monoceros *collected in attractant traps in Tanga and Coast regions before and after the release of* Baculovirus oryctes *infected beetles*

Areas	Pre-release period 1985		1986		Post-release period 1987		1988	
	males	females	males	females	males	females	males	females
Muheza	60	78	73	78	71	69	47	41
Tanga South	18	28	56	68	36	36	36	52
Vuo-Gezani	148	173	267	221	186	189	251	242
Chambezi	248	248	141	136	132	201	33	51
Sotele	134	181	273	149	284	307	27	87
Magawa	209	242	169	190	251	289	123	140
Totals	817	950	979	842	960	1091	517	613

Table 4. *Incidence of* Baculovirus oryctes *in* Oryctes monoceros *collected from attractant traps in Vuo-Gezani and Magawa areas (August 1985–December 1988)*

Area	Year	No. of beetles caught	No. of beetles diagnosed	Rate of infection (%)
Vuo-Gezani	1985	321	161	37.9
	1986	488	192	27.6
	1987	428	290	23.4
	1988	493	259	34.4
	Total	1130	902	30.0
Magawa	1986	359	199	20.6
	1987	540	289	33.9
	1988	263	118	20.3
	Total	1162	606	24.9

Table 5. *Incidence* Baculovirus oryctes *infection in* Oryctes monoceros *collected from breeding sites in Vuo-Gezani and Magawa areas (August 1985–December 1988)*

Area	Date	No. of beetles infected	Infection rate (%)
Vuo-Gezani	1985	32	31.3
	1986	87	11.5
	1987	–	–
	1988	31	9.8
	Total	150	15.3
Magawa	1986	154	31.3
	1987	337	39.2
	1988	136	30.9
	Total	627	35.4

symptoms of virus infection varied between 20.3 and 33.9% at Magawa and 23.4 and 37.9% at Vuo-Gezani (table 4).

However, the overall means for the sites did not differ significantly. Field-collected beetles showed a higher percentage of infection at Magawa (35.4, table 5) compared with Vuo-Gezani (15.3) but the sample sizes from Vuo-Gezani area were too small to allow for a comparison.

No collection could be made from breeding sites in the Vuo-Gezani area in 1987 because only very few dead logs could be found and their destruction might have resulted in an unacceptable interference with the reproduction of the field-population.

3.3 Damage surveys

The results of the damage surveys from the release and control areas are shown in fig. 1 (Tanga region) and fig. 2 (Coast region). At both release sites, the post-release figures show a decline immediately after the release. Average damage levels in Vuo-Gezani area fell from an average range of 30 to 45% before the release to below 20% and remained at that level.

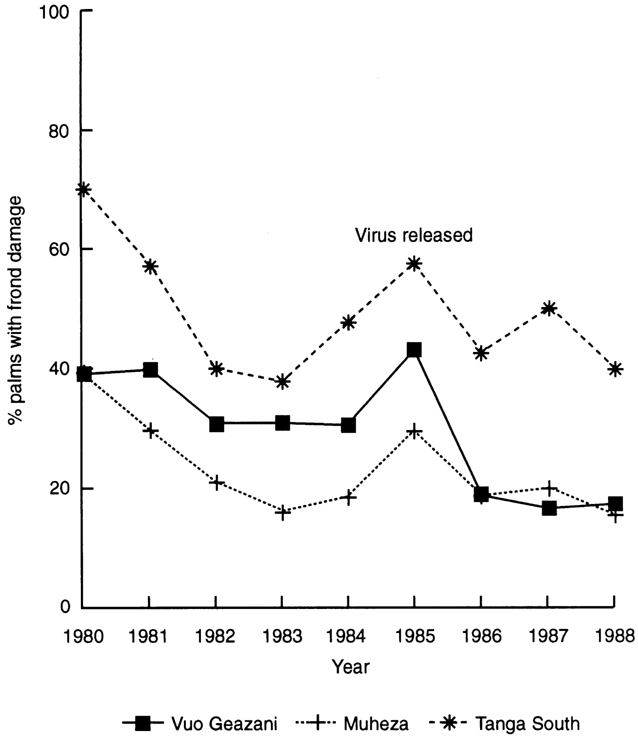

Fig. 1. *Percentage of five central fronds damaged by* Oryctes monoceros *before and after release of* Baculovirus oryctes *along the road to Mombasa and in two control (non-release) areas at Muheza and Tanga*

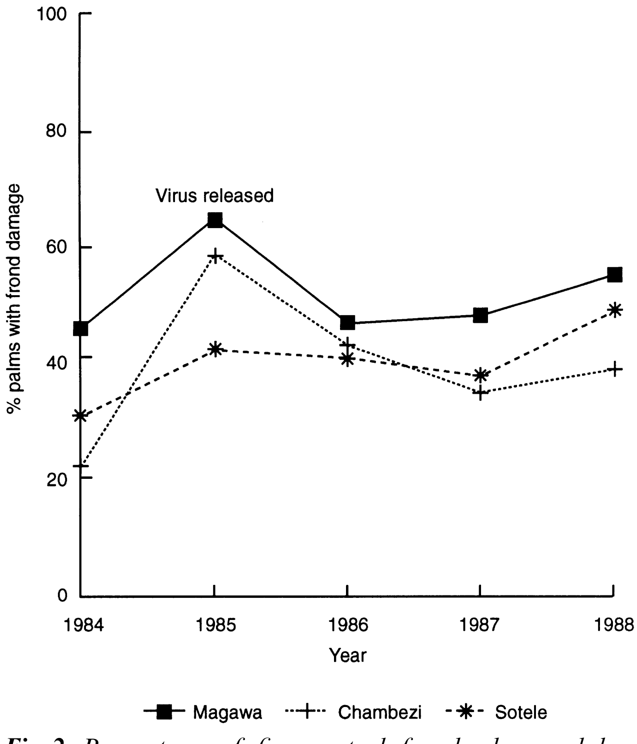

Fig. 2. *Percentage of five central fronds damaged by* Oryctes monoceros *before and after release of* Baculovirus oryctes *at Magawa and in two control (non-release) areas at Chambezi and Sotele*

At Magawa before the release, frond damage ranged between 55 and 66%. At the evaluation after the release, the damage was reduced to 46% but started to rise again later and has almost reached the pre-release level. However, similar fluctuations could be observed in the control areas (fig. 1).

4 Discussion

The diagnosis of trap and field-collected adults of *O. monoceros* revealed symptoms in the nuclei of their gut cells which are without any doubt due to virus infection. This could also be confirmed in bioassays using positively diagnosed midguts inoculated to healthy beetles in the laboratory. The infection rates of the trapped beetles, however, appear to be low in both release areas and were lower than the ones of field-collected beetles most of the time. This difference is easy to explain as a low-biased rate of infection of trap-caught beetles can be expected because the flight activity of seriously diseased beetles should be hampered by the virus and thus those beetles will not be caught in traps.

Therefore, a collection from breeding sites should give more realistic rates of infection. The mean rate of infection of field-collected beetles at Magawa was about 10% higher (table 5) than the one for trapped beetles. In Vuo-Gezani, comparable infection levels with those at Magawa were only recorded in 1986. However, small sample sizes do not permit a reliable estimation.

Not even the highest level of infection diagnosed in Tanzania (38%) was anywhere near the levels of over 84% in Tonga (Young and Longworth, 1981); 57 to 68% in Fiji (Bedford, 1980); and 43% in Western Samoa (Zelazny, 1979a,b) reported for *O. rhinoceros*. Lomer (1986) reported infection rates of 20 to 50% from the Seychelles on *O. monoceros*. Although he recorded infection rates from 70 to 90% on the island of Praslin, his average rate of 35% is comparable with the rates found in Tanzania (table 4). However, he claims a reduction of central frond damage of 35% whereas no clear evidence of a reduction was found in Tanzania (figs 1 and 2). A possible explanation for this difference could be Paul's (1985) findings that infected *O. monoceros* from Tanzania, were still alive whereas already 50% of those from the Seychelles had died.

Zelazny (1977) also found a significant effect of the virus on the sex ratio of field populations. Because of the higher percentage of transmission of virus from females to males than vice versa, the sex ratio became female-biased in cases of successful establishment of the disease. This was confirmed by Lomer (1986) for *O. monoceros* in the Seychelles. The results presented here, however, do not show a significant deviation from the normal sex ratio of 1.0 after the releases.

Oryctes-damage to fronds at both release sites was reduced to about half the pre-release levels in the year after the releases. However, levels at the control sites showed about the same range of fluctuation and it remains doubtful therefore whether the reduction of the damage can really be attributed to the action of the virus. The fact that many beetles were removed in the field by trapping and collecting from breeding sites could be one of the reasons for the decrease in damage.

A release in a restricted, possibly an island, area with close to 100% of the palms being damaged by *Oryctes* might have given a more clear-cut answer as to how effectively the virus can suppress damaging populations of *O. monoceros*. Moreover, we would like to point out that *O. monoceros* damage to coconuts is of economic significance mainly in young plantations. Older palms can tolerate fairly extensive frond damage without seriously affecting the plant. The whole subject of the pest status of *O. monoceros* is therefore confined to palms at their most vulnerable age. Such palms are easy to scout and feeding beetles can easily be detected and removed. It is proposed therefore that hook picking would be an effective method of *O. monoceros* control especially when complimented with sanitation measures such as removing dead coconut logs and making them unsuitable for breeding.

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