USING A VIRUS AGAINST RHINOCEROS BEETLES

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INTRODUCTION

Rhinoceros beetles are pests of coconut palms and are widespread in Papua New Guinea. One of the species of these beetles, *Oryctes rhinoceros*, can be controlled by a disease which is caused by a virus called baculovirus of *Oryctes*. Viruses are extremely small organisms which can only be seen using a special microscope. They cause diseases in both plants and animals. Examples of human diseases caused by viruses are influenza, hepatitis and dengue fever.

The baculovirus of *Oryctes* however is safe to use for rhinoceros beetle control. None of the baculovirus group of viruses have ever been found to cause diseases in human beings or plants. They are the only type of viruses that the World Health Organisation presently recommends should be used for insect control. Laboratory safety testing has shown that the baculovirus of *Oryctes* does not infect mammals, bees or other beneficial insects, but is restricted to *Oryctes* and possibly to related beetle pests.

The following article describes research into the release of the virus in Papua New Guinea in 1978.

THE BEETLES

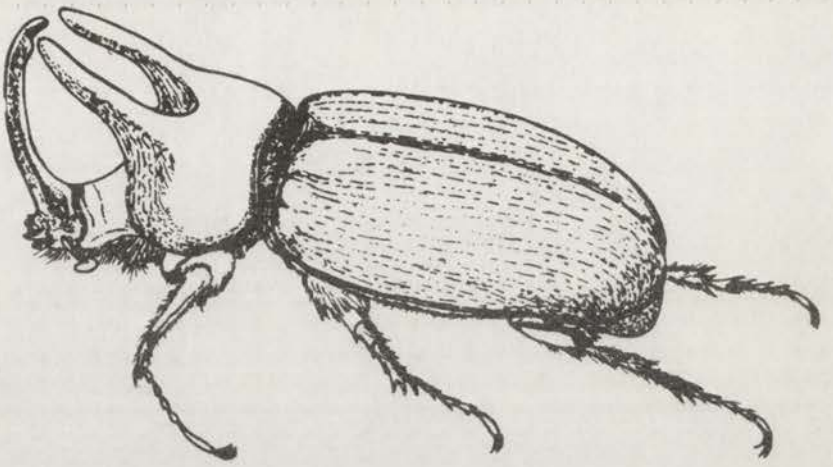
There are two main species of rhinoceros beetle which damage coconut palms in Papua New Guinea. One is called the Asiatic rhinoceros beetle, *Oryctes rhinoceros*, while the other is the New Guinea rhinoceros beetle, *Scapanes australis*.

Scapanes is one of the most important pests of coconuts. It is found in most of the coconut growing areas in this country. *Scapanes* adults attack young palms between one and five years old. A severe attack can kill large numbers of these palms.

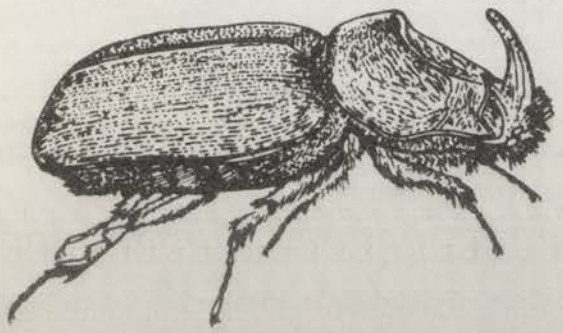
Oryctes is less important in this country because it occurs only on New Britain, Manus and New Ireland, where it attacks mainly older palms. However, it can be a very serious pest in those places.

Both types of beetles are most active at night and cause similar damage to coconut palms. This damage is caused by the adult beetle flying to the crown of the palm, boring into the heart of the plant and feeding on the plant tissue. This feeding damages the fronds before they open and on opening, they have characteristic V-shaped cuts. Attacks may kill the palm if the growing point is destroyed.

In addition, the holes made in the palm by the rhinoceros beetles attract palm weevils *Rhynchophorus bilineatus* the larvae (grubs) of which feed inside the palm and often cause its death.



Scapanes australis
Male, actual size



Oryctes rhinoceros
Male, actual size

Rhinoceros beetle larvae do not damage living palms. *Scapanes* larvae are found under logs of decaying bush trees while *Oryctes* larvae are found in dead standing palms or in rotting coconut logs. Adult *Oryctes* lay their eggs in these dead palms and the larvae feed on the rotting palm sawdust. The larvae pupate and then the emerging adult fly to the crowns of healthy palms and start feeding.

Damage to coconut fronds caused by rhinoceros beetles Photo: C. Prior

A typical breeding site for Oryctes
Photo: C. Prior

Several control organisms (biological control agents) have been used against *Oryctes*, but only one, the baculovirus of *Oryctes*, has been effective on a large scale. This is a virus disease which has so far only been used for the control of *Oryctes*. Current research at the Lowlands Agricultural Experiment Station (L.A.E.S.) is trying to discover whether this disease can also infect *Scapanes* beetles, and so help to control them as well. At present, D.P.I. recommends that *Scapanes* is controlled by insecticides (L.A.E.S. Information Bulletin No. 11).

The remainder of this article deals with the use of the baculovirus against *Oryctes*.

HISTORY OF THE VIRUS

The disease was first discovered in Malaysia in 1963, when some very sick *Oryctes* larvae were found to be infected by a virus which is now called the baculovirus of *Oryctes*. During the years following this discovery, a lot of research on the virus was carried out by workers of the South Pacific Commission Rhinoceros Beetle Project (based in Apia, Western Samoa). The main research went into finding out the type of virus; the effect of the virus on larvae and adults of *Oryctes*; how the disease is passed from insect to insect, and how best to release and spread the virus into the wild beetle population.

HOW THE VIRUS WORKS

The virus infects both the larvae and the adults of *Oryctes*. When larvae are infected they stop feeding within a few days, fail to develop normally, and generally die within 7-21 days after infection starts. An infected adult also stops feeding shortly after infection, and dies long before a healthy beetle does.

When the baculovirus infects the beetles, it kills them by changing the structure of the tissues inside them. Several parts of the insect (including the gut) are attacked by the virus and eventually change to such an extent that they no longer function properly and the insect dies.

When the gut of the beetle is infected with the virus, it becomes completely full of virus particles. These particles are passed out of the gut in the faeces (droppings) and are very infectious. Any other beetles coming into contact with these faeces, either during mating or during normal feeding activities, will be exposed to the virus and are likely to catch the disease. This is the main way that the disease is passed from insect to insect. An infected female adult can also pass the disease to larvae when she visits breeding sites to lay eggs. Infected beetles continue living and producing infectious faeces for several weeks and are responsible for spreading the virus to many other beetles at different sites.

A rhinoceros beetle which has become infected with the virus disease does not look any different from a healthy beetle. Only by microscopic examination of a small piece of gut from a beetle can the difference between a sick and a healthy beetle be seen. Symptoms of the virus disease in larvae can usually be seen just before the larvae die, since the sick larvae gradually become more transparent and sometimes change colour. The virus disease can only infect the adults and larvae of the beetle, and cannot be passed to the eggs or pupae.

Oryctes *larvae collected from one dead standing palm at Bunai, Manus Province. These larvae are being reared to adults in the laboratory Photo: C. Prior*

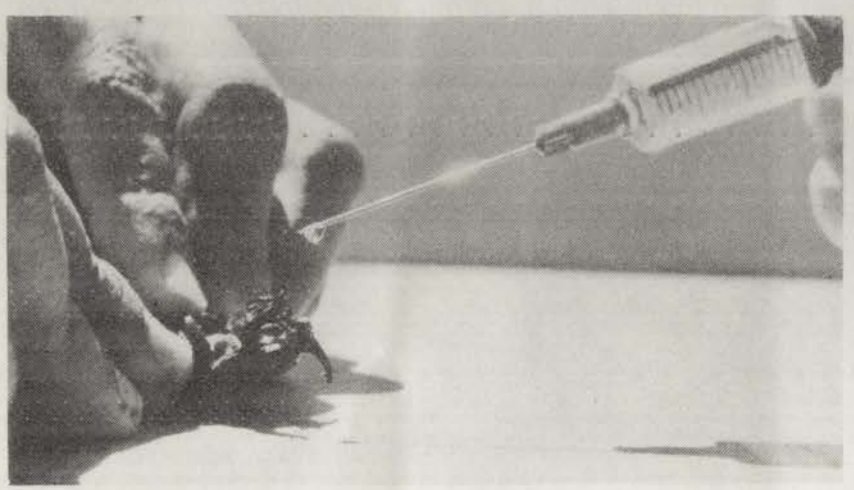
The virus was first released into a field population of *Oryctes* in March 1966 in Western Samoa. Several releases were made that year and by 1969 the virus had spread throughout the islands of Western Samoa. The virus was also released on other Pacific Islands such as the Tokelau Islands, Fiji, Tonga and the Wallis Islands and also on Mauritius and the Seychelles. Various studies conducted after the release of the virus showed that, in general, damaged palms began to recover fairly rapidly. As the disease spreads, more adult beetles become infected and stop feeding and more palms produce new, undamaged fronds.

THE VIRUS IN PAPUA NEW GUINEA

Work on the virus project in Papua New Guinea began at L.A.E.S. in September 1976. This early work concentrated on improving the technique of preparing insect guts for examination under the microscope.

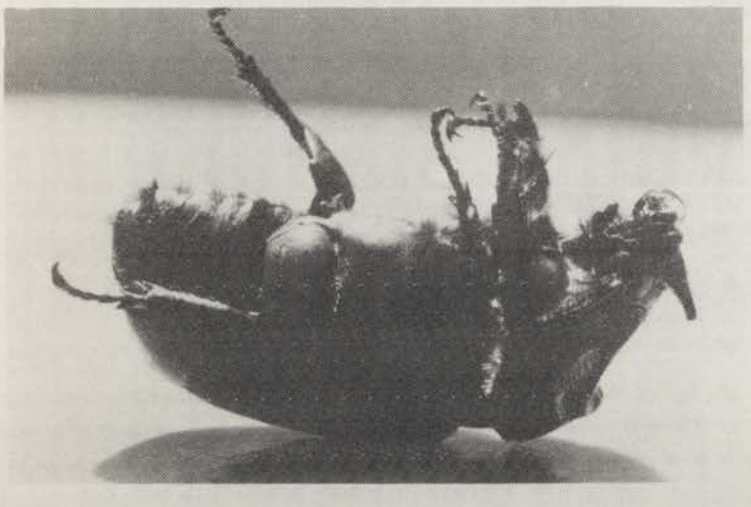
In October 1977, a shipment of frozen, virus-infected larvae was received from Western Samoa. These larvae were immediately ground up, diluted with water and mixed with sawdust to which healthy *Oryctes* larvae were added. When the healthy larvae ate the sawdust mixed with the virus, they became infected with the virus disease and died shortly afterwards. These dead virus-infected larvae were then deep frozen. This process was repeated several times until large numbers of virus-infected larvae had been produced and so a stock of virus was built up. These larvae were then used to infect adult beetles which are now used as the inoculum source for all new infections.

The virus is introduced into the field population of *Oryctes* by infecting the adult beetles. Beetles are collected in the field either as adults or as larvae which are then reared through to adults in the laboratory. When a large number of adult beetles is available they are infected with the virus using the "oral inoculum" technique. This involves holding each beetle on its back and placing a small drop of liquid, containing the virus, onto its mouthparts. After the beetle has sucked in the drop of virus liquid, it is ready to be released into the field.



Adult Oryctes *are infected by placing a drop of virus mixture on their mouthparts. This is the 'oral inoculum' technique Photo: C. Prior*

The oral inoculum is prepared by infecting a few adults from the frozen stock of virus. After ten days, these beetles are cut up and the guts removed. Any guts that are white and swollen, and are considered to be heavily infected with virus, are mashed up into a liquid. This liquid is divided into small quantities and can be kept deep frozen for a long time. Before it is used to infect the beetles, the virus liquid is mixed with some sugar solution. Because this virus mixture is sweet, the beetles quickly suck it up.



The drop of virus mixture on the beetle's mouthparts just before it is sucked up
Photo: C. Prior

When they are ready to be released, the beetles are taken to the release site and placed on the ground. They crawl away to hide under leaves until night when they fly to nearby coconut palms. After a few days these beetles produce virus-infected faeces and transmit the disease to other beetles.

Table 1 shows the number of releases of virus-infected adult *Oryctes* made in Papua New Guinea in 1978. These releases were concentrated on Manus, but, following reports of a rhinoceros beetle outbreak on the West Coast of New Ireland, they also began in New Ireland during the same year.

TABLE 1. RELEASE OF BACULOVIRUS INFECTED *ORYCTES RHINOCEROS* ADULTS IN PAPUA NEW GUINEA DURING 1978

Date	Number of beetles released	Site	Province
5 Jan	22	Nuwok	Manus
4 June	100	Koka	New Ireland
14 June	35	Lugos	Manus
27 Aug	40	Momote	Manus
5 Sept	17	Lombrum	Manus
19 Sept	39	Lombrum	Manus
10 Nov	27	Salami	Manus
24 Nov	30	Salasea	Manus
24 Nov	32	Nuwok	Manus
27 Nov	40	Bopire	New Ireland
29 Nov	27	Kalili	New Ireland
30 Nov	80	Kimadan	New Ireland
Total	489		

Andrew Kairak and Puria Kuluma release infected Oryctes *adults in the field Photo: C. Prior*

Towards the end of 1978, beetles caught from Lugos and Nuwok on Manus were found to have symptoms of virus infection when their guts were examined under the microscope. Early in 1979, virus-infected beetles were also recovered from Lombrum and Momote on Manus, and from Bopire in New Ireland. Further releases of virus-infected beetles on New Ireland are planned.

It is important to discover if palm damage has decreased after the virus has become established in the field and begun to affect the number of beetles. To do this, 100 palms are selected at each site. Once a month, these palms are examined and the number of undamaged, newly opened fronds is counted. These palm damage surveys will show the result of releasing the virus in the field. As more beetles become virus-infected, there will be less damage to the palms.

FURTHER WORK

During 1979, the first release of virus-infected *Oryctes* will be made on New Britain. This is the last remaining area of Papua New Guinea where *Oryctes* is present and where the virus has not yet been released. It is anticipated that a large number of beetles will be released and the virus should have become established by the end of the year.

Work will also continue to see if the virus can kill *Scapanes* as well as *Oryctes* beetles.

FURTHER READING

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