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## THE RHINOCEROS BEETLE (*ORYCTES RHINOCEROS L.*) IN SAMOA

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The following notes are based on studies made by the author in Samoa during May, June and July, 1913.

The rhinoceros beetle, *Oryctes rhinoceros L.*, has long been known as a more or less serious pest of coconut trees in many tropical countries. It is gradually extending its range and wherever it gains a foothold in a new country its ravages cause much worry and usually great financial loss.

The island of Upolu, German Samoa, is one of the recent places to suffer from the introduction of this pest. Its presence there was first noticed in the fall of 1910 when the ragged condition of some of the trees near the customs house in Apia caused an investigation to be made. As soon as their characteristic work was recognized there was evidence on every hand to show that the beetles were already well established there. Within a restricted area many of the coconut trees were badly injured and the larvæ were found abundantly in decaying wood, manure and other refuse. Just how the beetle was introduced into Samoa will probably never be known, but it is quite likely that young larvæ were brought in with soil and vegetable refuse packed around the stumps of rubber trees imported from Ceylon.

Unfortunately systematic attempts were not made to exterminate the pest when first discovered. Certain control measures were adopted but the fight was not carried on vigorously enough to keep the beetle from gradually spreading to all the districts near Apia and later to more distant parts of the island.

The prevailing northeast trade-wind has been a determining factor in the direction of the spread of the insect, the districts to the windward of Apia showing comparatively little damage. In the other direction practically all of the plantations are more or less affected, the infestation having passed around the end of the island and for

some distance up the other side. The beetle has also very recently appeared in limited numbers in the island of Savaii where it has probably been carried by the natives who are constantly passing back and forth, carrying quantities of mats, food and many other articles in which the beetles and larvæ or eggs might easily be transported.

In districts where infestation is the worst, hundreds of trees are being killed on many of the plantations and others are being so badly injured that, even should they recover, it will be some years before they will have a good crop of nuts.

As the beetles attack the most vital part of the tree, the succulent crown, one or two will quickly kill a young tree. Older trees are able to sustain greater loss but even a few beetles in them will soon make them unproductive, and, as the trees are sometimes attacked by as many as ten or fifteen beetles at once, even the sturdiest trees may succumb. The beetles usually attack the tree close to the base of some of the leaves, between the base of a leaf and the tree, or between the bases of two leaves. They are thus enabled to use their legs to brace themselves firmly while beginning their burrow. The strong curved horn on the head is also called into use as the beetles gnaw their way through the tough fiber. The head is lowered and the horn thrust into the fiber, then as the head is raised the body is drawn forward. As the beetles are usually an inch and a half long and about an inch in diameter the holes that they make in the base of the larger leaves are very conspicuous, particularly as the older leaves die and hang down. On their way toward the center of the plant the beetles usually cut through some of the young leaves, the pinnæ of which are still folded closely along the midrib. As these leaves unfold they present a very characteristic appearance looking as if they had been cut by shears. Having reached the tender heart of the tree the beetles feed on it probably for some weeks, often destroying much or all of it, thus killing the tree.

The beetles swallow but little or none of the fiber through which they bore. A study of their mouthparts shows that they are less fitted for biting and chewing than they are for boring and tearing and crushing. The inner surfaces of the heavy mandibles do not meet except at the extreme base, the triangular space between them being filled by the maxillæ and the tip of the labium. The outer margins of the maxillæ and the labium are furnished with a dense fringe of rather long stiff bristles which, with similar bristles on the labrum, serve as a sieve for straining out the particles of plant tissue that are torn loose by the mandibles and the two tooth-like projections above them. The mandibles and their projections tear the tissue of the plant into shreds and the juice which is crushed from it is strained

through the bristles with which the mouth is surrounded. Examination of the alimentary canal of many beetles failed to show any of the plant fiber. The importance of this will be seen when we come to consider control measures.

The life history of this insect has not as yet been thoroughly worked out but in Samoa it probably takes it at least a year to complete its development. The eggs, which are laid in batches of ten to thirty, hatch in a very short time and the larvæ feed for several weeks, possibly for some months. In Samoa the larvæ are found most commonly in old decaying coconut logs or stumps, in places where these occur, but other rotting wood or decaying vegetable matter of any kind seems to furnish an abundance of food. The cacao pods that are often left in piles in the field furnish excellent breeding places. The larvæ are not commonly found in the living trees, but, if the crown is badly injured and contains much decaying matter, they may sometimes occur there.

One tree about twelve years old that, when standing, appeared to be only moderately injured was cut down and found to contain fifteen beetles, twenty-four larvæ, one third to one half grown, three smaller larvæ and a few eggs. A few larvæ and eggs were also found in other trees so that it is possible that, when the breeding places on the ground are not so readily available, more of the beetles will lay their eggs in the injured trees.

Unless a special search is made for them the pupæ are rarely seen and they are never found in any considerable numbers. Those that are found are usually in well-formed cells in portions of the log that are a little firmer than that in which the larvæ commonly work. Many of the larvæ probably enter the ground and pupate some distance below the surface. The pupal stage lasts for about ten days or two weeks. It is very difficult to rear the beetles from pupæ that have been taken from their cells. Not only are the pupæ very easily injured but they do not seem to be able to live except under the most favorable conditions. After the beetles issue they remain in the logs for a few days, waiting for the body wall to harden. Their flight is slow, heavy and, in the breeding cages at least, not very long sustained. In a cage 8 x 8 x 16 feet the longest flight noted was two and one half minutes. They probably would fly for a much longer time outside. They fly only at night, and sometimes come to lights, but even the brightest lights do not attract them in great enough numbers to be of any value in control work.

In Samoa many control measures have been tried. In the effort to protect the trees from attack, many substances which were supposed to act as repellants have been used. Our observations and experi-

ments seem to show that tar is the most effective of these, but even its use gives only a small measure of protection. Many planters simply painted the tar on the outside of the base of some of the leaves, but this soon became dry and hard and of little value. As kerosene was often added to the tar more or less damage to the tree often resulted and, in some cases, when equal parts of kerosene and tar were used, many trees were killed. As the kerosene adds little or nothing to the repellent value of the tar and as it is not needed for a thinner, there is no excuse for using it in this way. In experimenting with this material many young trees, ten to fifteen years old, were thoroughly cleaned by cutting out all the dead leaves, flower stems, etc., and then examining the tree carefully to see whether any beetles were already in it. Sometimes it was necessary to cut away some of the green leaves also before the beetles could be reached. A rather stiff wire with a hook or barb on the end of it was often found convenient for spearing the beetles and pulling them from their holes when they were deep in the tree. If the tree was badly infested with beetles it was often found necessary to remove nearly all of the old leaves before it could be thoroughly cleaned. After the beetles were removed all of the new-cut surfaces and the inner side of the base of the leaves were painted with tar, particular care being taken to treat thoroughly all of the holes and any open spaces where the beetles might enter. Alternate trees cleaned in the same way, but not treated with tar, and other trees from which few or none of the leaves were cut, were left as checks. An examination forty days later showed that the trees treated with the tar had fewer beetles in them than the check trees had, but the fact that many of the tarred trees were attacked by one or more beetles shows that this treatment offers only a small measure of relief.

Other trees were treated with lysol and some with lysol mixed with the tar, but as many of the leaves, especially the young leaves, were badly injured it was found that this substance could not be used for this purpose.

Coarse beach sand was poured into the crowns of a few trees, care being taken that plenty lodged at the bases of all of the leaves. Still other trees were treated in the same way with very fine sharp sand. When the trees were last examined only one had been attacked by the beetles, but not enough time had elapsed to make the experiment of any value. A little white arsenic was mixed with the sand in some of the trees. When such a mixture touched the young leaves they were usually more or less injured.

A few trees were dusted thoroughly with white arsenic, others with Paris green, still others were treated with these arsenicals mixed

in water. Such trees were covered with a netting under which a few beetles were placed. A few days later three beetles were found dead in the nets; three had bored into the trees and were apparently unaffected by the arsenic, but most of the beetles had escaped by tearing holes in the netting. In order that these arsenical sprays might be given a thorough test the crowns were cut from a few trees and the leaves all trimmed off. This part of the tree was very thoroughly treated, great care being taken that all exposed surfaces received some of the arsenic. They were then placed in a large cage where a few beetles were confined. Sometimes as many as four out of ten beetles would be found dead in the cage the next day, but many of the beetles entered the tree and were apparently unharmed by the presence of the arsenic. No tests were made to determine whether the dead beetles were killed by the arsenic. It was quite common to find some dead beetles in the cage even when the trees that were placed therein were not treated. The results of these experiments are such as we would expect after studying the mouth-parts and feeding habits of the beetle, for little or none of the arsenic would find its way into the stomach unless the leaf or stem fiber was swallowed.

In an effort to kill the beetles in the trees, without cutting the tree as much as was usually necessary, a little carbon bisulphide was poured into some of the holes after the mass of chewed-up fibres had been removed. The beetles were always quickly killed, but, unfortunately, the trees were always badly injured by the liquid and young trees were often killed.

During the last two years a long series of experiments have been made in an attempt to attract the beetles to various kinds of traps to lay their eggs. The trap very commonly used is made of pieces of rotting logs piled in a neat pile and partly covered with earth. Cacao pods, manure and other decaying vegetable matter adds to the efficiency of the trap. If no other breeding places are convenient the beetles may be attracted to these traps in considerable numbers. At regular intervals, usually every six or eight weeks, these traps are examined and the rotting logs split up and the beetles, larvæ and eggs found therein destroyed. If this work is carefully done it is quite effective on well-cleaned plantations, but it is expensive and requires close supervision. If the traps are made of small pieces of well-rotted wood, cacao pods or other decaying vegetable matter mixed with a little earth, the whole mass may be treated successfully with carbon bisulphide by pouring a little of the liquid in holes in various places over the trap. This will kill all of the beetles and larvæ except those

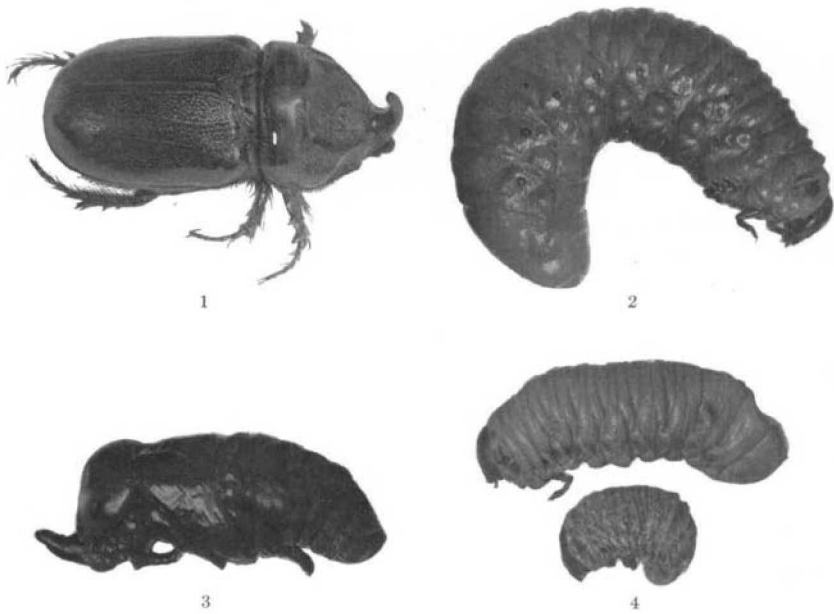
that are well protected in the wood. But this treatment is expensive and only successful when the traps are carefully made.

For the present at least then, the most effective method of control is to destroy the breeding places of the beetle. In an old well-kept plantation this is easily done, but on new plantations the problem is a very serious one, for, without very heavy expense, it takes a long time to burn or destroy all the old logs and stumps. Coconuts and often cacao trees are usually planted within one or two years after the bush land has been first cut over and while many of the larger trees are still lying unburned on the ground. As some of the bush trees are very hard they decay slowly and it is sometimes several years before they can be cut up or burned easily. As long as any of these decaying trees are in the field they are a constant menace to the surrounding coconut trees. Plantations near wild bush land have the dead trees there to contend with also.

Piles of cacao pods are favorite breeding places for the beetles, and when these are buried, as they often are in an effort to check the spread of the cacao canker, they become even more dangerous for the beetles readily find them and breed there in great numbers. The pods should be burned soon after they are opened unless some method of treating them can be found whereby they will not endanger the cacao trees or serve as breeding places for the beetle.

Realizing that it is impossible, because of lack of funds or labor, for some of the planters to clean up the land the local government has very wisely begun to aid them in this work. This is as it should be. This insect is a common foe and it is just as much the function of the government to protect its subjects from it as it is to protect them from invasion by another nation. The problem is largely a question of labor and will probably be satisfactorily solved only when the government can put enough men on the infested plantations to clean them as they should be.

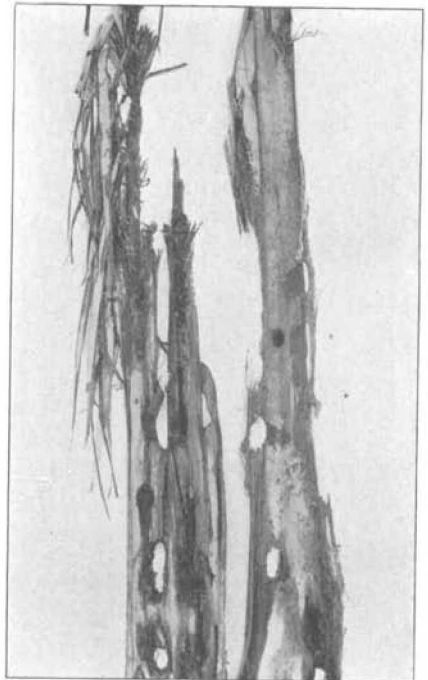
Careful searching and breeding experiments have failed to reveal any insect parasite of this beetle in Samoa, nor is any such natural enemy known to occur in other countries. It is quite possible, however, that a careful search in places where the beetle has long been established may reveal some important enemies. Dr. Friederichs, zoölogist and plant pathologist for Samoa, has been working for some months with a fungus disease that is found attacking a very few of the larvæ on some of the plantations. Under laboratory conditions this can be made to do very good work but so far it has spread too slowly in the field to do very much good. It is possible that further experiments may teach us how to make this a valuable ally in our fight against this important pest.



RHINOCEROS BEETLE

1, *Oryctes rhinoceros* L.; 2, Larva of same; 3, Pupa of same; 4, Two larvæ of same that have been killed by a fungus.  
(All natural size.)





1, Coconut trees affected by *Oryctes rhinoceros* L.; 2, Closer view of a badly affected tree. 3, Leaves cut by the beetle before unfolding; 4, Base of leaves injured by beetles.