The status of Coconut Rhinoceros Beetle, *Oryctes rhinoceros* (L) Scarabaeidae : Dynastinae, in Solomon Islands.

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ABSTRACT

Oryctes rhinoceros, coconut rhinoceros beetle (CRB), was first confirmed as present in Honiara, Solomon Islands in January 2015. Based on initial delimiting surveys it was determined that it had likely been there for at least two generations before it was detected and that consequently eradication was not an option. Soon after, scientists at AgResearch, New Zealand, confirmed it was the 'G' (Guam) strain of the species that is not susceptible to the nudivirus that controls another strain of CRB elsewhere in the South Pacific. An emergency response plan was developed but due to inadequate financing implementation has been inconsistent and weak, consequently it has spread and is now reported on parts of seven islands. More recently some funding has become available and a three-pronged management approach is being implemented: sanitation to reduce populations by destroying breeding sites (rotting palm logs, green manure, compost and chicken manure), restricting spread through internal quarantines on shipping and biological control by identifying effective entomopathogens for the long term. Work to identify strains of *Oryctes Nudivirus* (OrNV) effective against CRB-G is reported elsewhere in this symposium. Some preliminary details of work to introduce the green muscardine fungus, *Metarhyzium anisopleae*, are reported here.

Background

Coconut rhinoceros beetle (CRB), *Oryctes rhinoceros*, is the most serious insect pest of coconuts wherever it occurs. Estimates of losses vary considerably from 50% palm mortality and significant yield losses to the remaining palms in Palau (Gressitt 1953) to losses of US1,100,000 to South Pacific countries from reduced yields in 1968 alone (Catley 1969). Figure 1. provides a clear demonstration of palm mortality in Fiji in the mid 1960s. Similar scenes are seen in Solomon Islands today.

Figure 1. Palm mortality in Fiji mid 1960s. Bedford , 2013. Ann. Rev. Ento.

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The centre of origin for CRB is thought to be SE Asia particularly; Malaysia, Myanmar, Thailand, Indonesia, Viet Nam, South China and the Philippines. It has subsequently spread more widely to India, Mauritius, Maldives and Reunion (Waterhouse 1987) and the Arabian peninsula. It first entered Oceania in 1909 when it arrived in Samoa with rubber seedlings from Sri Lanka, this infestation subsequently spread to Wallis (1931), Tonga (1951), Fiji (1953) and Tokelau (1963). A second introduction occurred in 1942 when it arrived in New Britain and Palau and subsequently spread to New Ireland in 1952 (Lever 1969). The third and latest spasm of attacks began in Guam in 2007 and spread to Hawaii (2013), Port Moresby, PNG, (2014), Honiara, Solomon Islands (2015) and Palau and Yap more recently.

The attack in Solomon Islands

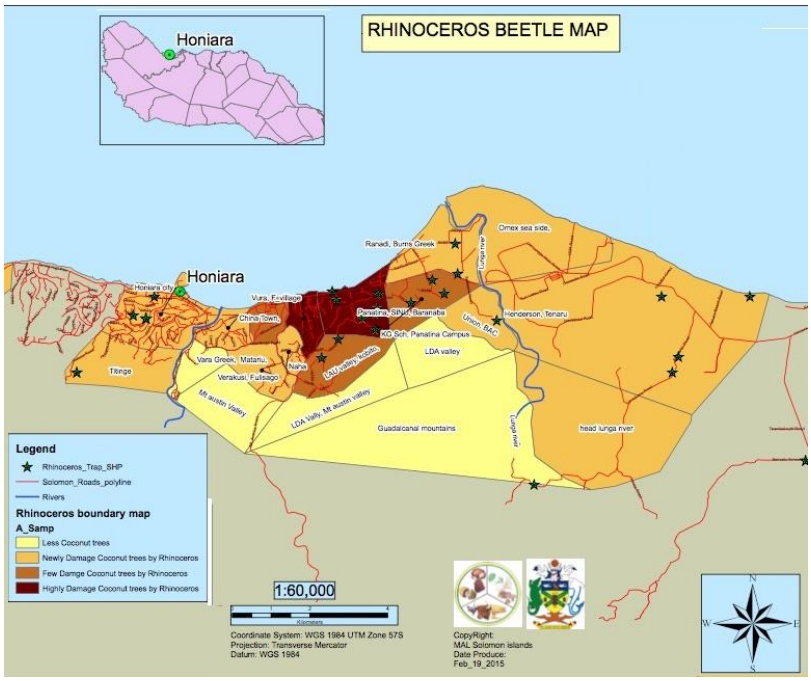

Figure 2. Results of the initial delimiting survey.

Symptoms of CRB attack were first reported in Honiara, Solomon Islands, in January 2015 and adults were collected soon after to confirm the identity as *Oryctes rhinoceros*. It was necessary to obtain adults before confirming the identity as there is an indigenous dynastid beetle, *Scapanes australis*, which causes similar damage to young palms. An Emergency Response Plan was immediately put into effect and a delimiting survey carried out based on signs of frond damage. The results of this survey (Figure 2.) clearly demonstrated that the attack had been underway for some time and eradication was impossible.

At the same time specimens were sent to Dr. Sean Marshall of AgResearch in Christchurch, New Zealand, who confirmed it to be the 'G' (Guam) strain of CRB. This strain cannot be controlled by the virus disease which controlled an outbreak of CRB elsewhere in the South Pacific in the 1960s and 70s. The plan switched to containment and population control. Since then the beetle has spread 60+ kms east and west along the north coast of Guadalcanal and to five additional islands, Russell Islands (2 islands), Savo, Ngella, N. Malaita and Ulawa.

CRB is also attacking the commercial oil palm plantation east of Honiara. The situation here is particularly unfortunate as the company had recently begun a replanting programme and hundreds of felled, rotting, thirty-year-old palms were lying on the ground in the replanted plantation as perfect breeding sites for the new beetle. The company has recently begun destroying these dead palms but has had to use insecticides to protect the newly planted palms.

The second strain of CRB, the susceptible, CRB-S, strain is also present in Solomon Islands. This was discovered in the Shortland Islands in the extreme west of the country, but based on anecdotal evidence it is thought likely that this had been there for 10-15 years already. Its presence and identity were only confirmed in mid 2015 after CRB-G was confirmed in Honiara. More recently CRB-S was also confirmed in the capital of the Western Province, Gizo. The campaign against CRB-G is being enlarged to include Gizo and Shortland Islands.

Containment and control

In Solomon Islands the responsibility for response to pest incursions rests with Biosecurity Solomon Islands (BSI) who immediately sought additional emergency funds from central government for the work. No new funds were forthcoming and until this year BSI has had to rely on its normal recurrent budget to mount its response, with predictable results.

The first additional funds BSI was able to obtain came from the Food and Agriculture Organization of the United Nations (FAO) and this was targeted primarily at an awareness campaign and the introduction of the entomopathogens, *Metarhyzium anisopliae* and *Oryctes Nudivirus* (OrNV). Elements of the awareness campaign were carried focused on raising awareness of the significance of the problem, the likely consequences and advising farmers on the best actions to take to reduce the impact of CRB in village agriculture. Unfortunately due to the funding requirements of the FAO support it was not possible to implement all the proposed awareness activities.

Potential impact

At this point it is worth perhaps emphasising the potential impact of this pest incursion to Solomon Islands. Currently the impact is small but as the beetle spreads to new places the impact will grow and if yield losses reach those of elsewhere the effect will be dramatic. Fifty percent palm mortality and yield losses to the remaining palms as reported elsewhere will significantly impact the country. The direct financial effects are easiest to imagine with copra, coconut oil and palm oil exports currently valued anywhere between US$300 and 400 million per year or 10-15% of GDP. However the social costs could be much more significant; for example, it is estimated that Solomon Islanders consume on average at least one coconut each per day, i.e. 600,000+ nuts per day. Loss of this will likely lead to increased consumption of poor quality cheap foods such as noodles and sugary soft drinks with the consequent increase in non-communicable diseases. Additionally, village copra production peaks when school fees are due; if copra is not available fewer children will be educated with consequent incalculable consequences for the future of the country. Of course the coconut, the tree of life, is well known to have a myriad of other uses from thatching to building materials, to artifacts and pictures of tropical beaches.

Action in the field

Until the arrival of CRB in Solomon Islands coconut plantation maintenance merely involved keeping the weeds down so fallen nuts could be found easily. Dead palms and green manure could be left to rot in-situ, on the ground or even standing. Now all dead palms will have to be removed from plantations either by using the wood or destroying them, and green manure will have to be spread out, or turned over regularly to expose larvae, or destroyed. These are significant, permanent, changes in behavior that will be essential for infested and non-infested plantations alike.

All publicity now stresses the behaviour changes required. A national campaign is being planned and will be implemented at the start of a New Zealand funded project to clean-up dead and rotting palms in infested and non-infested plantations. This project begins clean-up activities later this month and plans to systematically visit all infested plantations and work with communities to do the initial heavy work of removing dead and rotting palms. The project will run for 18 months, at least, and move into non-infested plantations as time and finance allows.

Release of entomopathogens.

Commercial consignments of the green muscardine fungus (GMF), *Metarhyzium anisopliae*, were imported from Malaysia in early 2015 and advice and training under the FAO project were provided to try to bulk up supplies locally and develop techniques to release it in infested plantations. This work has continued but is increasingly focusing on improving the techniques for release as bulking the fungus in sufficient quantity and with sufficient quality control has proved very difficult. Commercial supplies of the fungus are being obtained from Malaysia.

Fungus release techniques have focused on the design/size and content of artificial breeding sites and different inoculation methods. The latter include direct spraying of spores into the breeding site, and application of infected larvae. At all times care is taken to minimise the exposure of spores to sunlight. Results have been promising, Table 1, with anecdotal reports of reduced damage in treated plantations and the collection of fungus infected larvae from rotting dead standing palms in infected plantations. Work is continuing to refine the design and management of

rearing sites with project support from the Solomon Islands Rural Development Programme and the two New Zealand projects.

Media Composition	Depth of Media	No of Sites	GMF Spore Application Methods	Infection % after 3 wks
Chicken manure & wood savings	30 cms	10	Dead infected larvae	85%
Chicken manure & empty oil palm fruit bunches	30 cms	15	Spore suspension	66%
	30 cms	15	Dead infected larvae	72%

Table 1 : Summary of results for GMF application to artificial breeding sites

Work on *Oryctes Nudivirus* (OrNV) has been necessarily much slower. Initially FAO support enabled training in laboratory bioassay techniques and the testing of some strains of OrNV held by AgResearch, New Zealand. Some early encouraging positive results were obtained but BSI was not able to sustain the laboratory work on its own and focused instead on building a laboratory for rearing beetle adults of known age ready for more intense virus testing and release later. Subsequently the New Zealand government approved a project aimed at helping Solomon Islands and Papua New Guinea identify, bulk up and release a new virus that would be effective against CRB. This project began in January 2018 and is assisting BSI to test a range of OrNV strains to hopefully identify one that is effective against CRB-G for managed release. Early results are encouraging.

In all this work BSI is collaborating closely with the local commercial oil palm company, Guadalcanal Plains Palm Oil Limited (GPPOL), who are supported by their overseas parent company, Syme Derby. This company has contracted two entomologists, one based on Guadalcanal to test virus strains with BSI and one based in Asia to seek out the centre of origin of CRB-G and any effective entomopathogens that might be there.

Other activities

In addition to the above, BSI is also undertaking activities to manage the movement of CRB around the country particularly by ships and canoes. This relies on publicity campaign but BSI is also investigating the practicality of regulations. BSI is also carrying out monitoring and surveillance to determine spread and identify new incursions as quickly as possible after they occur. For this pheromone traps are being deployed at non-infested ports around the country and monitored regularly by trained village personnel.

The Research Division of the Ministry of Agriculture and Livestock (MAL) is also carrying out studies to test pheromones from different sources plus improve the efficacy of pheromone traps.

The Future

Action against CRB in Solomon Islands has got off to a slow start essentially because national emergency response funds were not forthcoming and now infestations are found at several sites around the country. But this year funding sources have begun to come on stream and significant actions are anticipated including:

- A publicity campaign aimed at changing village community coconut management practices for the long term.
- A campaign to clean-up infested village community coconut plantations free of rotting palm logs and green manure.
- Research into improved methods of green muscardine fungus release and spread.
- Research to identify virus strains lethal to CRB-G.
- Research into the release and spread of an effective virus.
- Monitoring and surveillance of spread within the country.

The prospect for CRB control in Solomon Islands is improving but considerable work will be required over the next year or so if severe consequences are to be averted.

Acknowledgments

The following are acknowledged for their support to actions against CRB in Solomon Islands.

Source	Manager/Facilitator	Activity
New Zealand	AgResearch	CRB disease studies
New Zealand	MAL/SPC	CRB Clean-up and surveillance
Australia	PHAMA	CRB Coordinator post
Australia	Strongim Bisnis	Design awareness campaign
Australia	ACIAR	CRB disease studies
FAO	MAL/BSI (completed)	Awareness & disease studies
FAO	SPC	Beetle disease studies
EU	SPC	Awareness materials
Sime Derby	OPRA/GPPOL	Beetle disease studies
SI Govt.	MAL/BSI	Begin clean-up and surveillance

References

Bedford. G.O. 2013. Biology and Management of Palm Dynastid Beetles: Recent Advances. Annu. Rev. Entomol. 58:353–72

Catley, A. 1969. The coconut rhinoceros beetle *Oryctes rhinoceros* (L). *PANS* 15 : 18-30

Gressitt, J. L. 1953. The coconut rhinoceros beetle *(Oryctes rhinoceros)* with particular reference to the Palau Islands. *Bull. Bernice P Bishop Mus. No. 212.* 157 pp.

Lever, R.J.A.W. 1979. Pests of the Coconut Palm. Food and Agriculture Organization of the United Nations, Rome. *Plant Production and Protection Series No. 18*. 190 pp.

Waterhouse, D.F, & Norris, K.R. 1987. Biological Control Pacific Prospects. Australian Centre for International Agricultural Research, Inkata Press Pty. Ltd., Melbourne. 454 pp.