Biodiversity capacity building in Papua New Guinea and sustainable development of its primary industries

INSECT DIAGNOSTICS WORKSHOP

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PORT MORESBY

Supplementary materials on Insect Pests

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Insect pests in Papua New Guinea

These tables comprise important insect pests in agriculture and forestry for Papua New Guinea and have been compiled from the publication by Waterhouse (1997), titled *The Major Invertebrate Pests and Weeds of Agriculture and Plantation Forestry in the Southern and Western Pacific*. This publication sought to bring together all the important pests for the Pacific region in order to determine appropriate target subjects for biological control so as to best assist the region in control of pests. As most of the problem pests in the region and in Papua New Guinea are introduced then they are also likely suitable to be investigated for possible biocontrol agents.

The information was compiled by country and pests were placed in four categories as follows:

- *+++ very widespread and very important*
- *++ widespread and important*
- *+ important locally*
- *P present, but not an important pest*

These tables present the insect pests for PNG in the top two categories, their Order and Family and the crops that they affect. The last column indicates whether a PestNet information factsheet is available for that pest, and these are accessible here:

http://www.pestnet.org/

Insects comprise all of the top 10 invertebrate pests of agriculture in PNG.

Some of these pests may now not be such as issue due to an effective biocontrol being introduced and there may also be new serious pest emergences in PNG which are not included, for example the cocoa pod borer.

Tables included

Table 1: Top 10 invertebrate pests of agriculture in PNG (are all insects)

Table 2: Major insect pests of agriculture in PNG: widespread and important (++)

Table 3: Major insect pests of agriculture in PNG: very widespread and important (+++)

Table 4: Major insect pests of forestry in PNG: widespread and important (++)

Table 5: Major insect pests of forestry in PNG: very widespread and important (+++)

Reference

Waterhouse, D.F. 1997. The major invertebrate pests and weeds of agriculture and plantation forestry in the southern and western Pacific. ACIAR Monograph No. 44, 99p.

Table 1: Top 10 invertebrate pests of agriculture in PNG*

Species	English common name	Family	Order	Principal crops attacked
Papuana spp.	Taro beetle	Scarabaeidae	Coleoptera	Taro, sweet potato, oil palm, banana
Bactrocera spp.	Fruit fly	Tephritidae	Diptera	Most fruit, some vegetables
Scapanes australis	Scapanes	Scarabaeidae	Coleoptera	Coconut, palms
Oribius spp.	Shot hole weevils	Curculionidae	Coleoptera	Horticultural crops
Cylas formicarius	Sweet potato weevil	Apionidae	Coleoptera	Sweet potato
Plutella xylostella	Diamondback cabbage moth	Yponomeutidae	Lepidoptera	Crucifers
Pseudodoniella pacifica	Cocoa mirid	Miridae	Hemiptera	Cocoa
Pantorhytes sp.	Cocoa weevils	Curculionidae	Coleoptera	Cocoa
Epilachna spp.	Leaf-eating ladybirds	Coccinellidae	Coleoptera	Legumes, cucurbits, Solanaceae
Riptortus spp.	Bean pod suckers	Coreidae	Hemiptera	Beans, legumes

* These species are all listed in the below tables

Table 2: Major insect pests of agriculture in PNG: widespread and important (++)

Species	English common name	Family	Order	Principal crops attacked	PestNet Factsheet
Acria sp.	Oil palm webworm	Xylorictidae	Lepidoptera	Oil palm	
Agrotis ipsilon	Greasy cutworm, black cutworm	Noctuidae	Lepidoptera	Polyphagous	
Aleurodicus dispersus	Spiraling whitefly	Aleyrodidae	Hemiptera	Papaya, guava, polyphagous	Yes
Amblypelta cocophaga	Fruit spotting bug	Coreidae	Hemiptera	Coconut, cacao, rubber, cassava, mango, papaya	Yes
Aonidiella aurantii	California redscale	Diaspididae	Hemiptera	Citrus, breadfruit, coconut, banana, papaya	
Aphis craccivora	Cowpea aphid	Aphididae	Hemiptera	Legumes, citrus, mango, breadfruit	Yes
Austracis spp.	Grasshoppers	Acrididae	Orthoptera	Polyphagous	
Baeturia papuensis	Grass cicada	Cicadidae	Hemiptera	Sugarcane roots, coffee	
Bruchophagus muli	Lime gall wasp	Eurytomidae	Hymenoptera	Citrus	
Ceroplastes rubens	Pink wax scale	Coccidae	Hemiptera	Citrus, polyphagous	
Cosmopolites sordidus	Banana weevil borer	Curculionidae	Coleoptera	Banana, sugarcane	Yes
Dermolepida nigrum	-	Scarabaeidae	Coleoptera	Banana leaves	
Epilachna spp.	Leaf-eating ladybirds	Coccinellidae	Coleoptera	Legumes, cucurbits, Solanaceae	Yes
Erionota thrax	Banana skipper	Hesperiidae	Lepidoptera	Banana	Yes
Eurycantha sp.	Oil palm stick insect	Phasmatidae	Orthoptera	Oil palm	
Helicoverpa (=Heliothis) armigera	Cotton ballworm, corn earworm	Noctuidae	Lepidoptera	Polyphagous	Yes
Hellula spp.	Cabbage centre grubs	Pyralidae	Lepidoptera	Brassicas	Yes
Hippotion celerio	Taro hawkmoth	Sphingidae	Lepidoptera	Taro, sweet potato, tobacco	Yes
Lepidiota reuleauxi	White grub	Scarabaeidae	Coleoptera	Sugarcane roots	
Leucoptera spp.	Winged bean, blotch miner	Lyonetiidae	Lepidoptera	Beans	
Lipaphis erysimi	Mustard aphid	Aphididae	Hemiptera	Cabbage, tomato, radish	Yes
Mahasena corbetti	Rough bugworm	Psychidae	Lepidoptera	Oil palm	
Myzus persicae	Green peach aphid	Aphididae	Hemiptera	Polyphagous	Yes
Nacoleia (=Lamprosema) octasema	Banana scab moth	Pyralidae	Lepidoptera	Banana, pandanus	Yes

Table 2 (continued): Major insect pests of agriculture in PNG: widespread and important (++)

Species	English common name	Family	Order	Principal crops attacked	PestNet Factsheet
Nezara viridula	Green vegetable bug	Pentatomidae	Hemiptera	Vegetables	Yes
Nilaparvata lugens	Brown planthopper	Delphacidae	Hemiptera	Rice	Yes
Ophiomyia phaseoli	Bean fly	Agromyzidae	Diptera	Beans	
Pansepta teleturga	Cocoa webworm	Oecophoridae	Lepidoptera	Cocoa	
Rhyparidella sobrina	Banana scarring beetle	Chrysomelidae	Coleoptera	Banana	
Scirpophaga excerptalis	Tip shoot borer	Pyralidae	Lepidoptera	Mature sugarcane	
Selenothrips rubrocinctus	Red banded thrips	Thripidae	Thysanoptera	Mandarin, mango, cocoa, cashew	
Sesamia grisescens	Pink stem borer	Noctuidae	Lepidoptera	Rice, sugarcane	
Spodoptera exempta	Lawn armyworm	Noctuidae	Lepidoptera	Polyphagous	
Tarophagus colocasiae	Taro plant hopper	Delphacidae	Hemiptera	Taro	Yes
Tarophagus persephone	Taro plant hopper	Delphacidae	Hemiptera	Taro	Yes
Tarophagus proserpina	Taro plant hopper	Delphacidae	Hemiptera	Taro	Yes
Thosea spp.	Cup moth	Limacodidae	Lepidoptera	Polyphagous on tree crops	
Tirathaba rufivena	Coconut spathe moth	Pyralidae	Lepidoptera	Coconut	Yes
Unaspis citri	White louse scale, citrus snow scale	Diaspididae	Hemiptera	Citrus	Yes

Table 3: Major insect pests of agriculture in PNG: very widespread and important (+++)

Species	English common name	Family	Order	Principal crops attacked	PestNet Factsheet
Amblypelta lutescens (=A. papuensis)	Fruit spotting bug	Coreidae	Hemiptera	Coconut, cacao, rubber, cassava, mango, papaya	
Amrasca devastans (=A. biguttula)	Cotton leafhopper	Coreidae	Hemiptera	Cotton	Yes
Aulacophora spp.	Pumpkin beetles	Chrysomelidae	Coleoptera	Cucurbits	Yes
Bactrocera spp.	Fruit fly	Tephritidae	Diptera	Most fruit, some vegetables	Yes
Brontispa longissima	Coconut leaf hispa	Chrysomelidae	Coleoptera	Coconut	Yes
Chilo terrenellus	Sugarcane internode borer	Pyralidae	Lepidoptera	Sugarcane	
Coccus celatus	Coffee green scale	Coccidae	Hemiptera	Coffee	
Coccus viridis	Green scale	Coccidae	Hemiptera	Coffee, polyphagous	
Crocidolomia pavonana (=C. binotalis)	Cabbage cluster caterpillar	Pyralidae	Lepidoptera	Cabbage	Yes
Cylas formicarius	Sweet potato weevil	Apionidae	Coleoptera	Sweet potato	Yes
Deanolis (=Noorda) albizonalis	Red banded mango borer	Pyralidae	Lepidoptera	Mango	
Earias vittella (=E. fabia)	Rough bollworm, shoot and fruit borer	Noctuidae	Lepidoptera	Aibika, okra	Yes
Euscepes postfasciatus*	Indian sweet potato weevil	Curculionidae	Coleoptera	Sweet potato	Yes
Leptoglossus gonagra (= Fabrictilis gonagra)	Squash bug, leaf-footed plant bug	Coreidae	Hemiptera	Cucurbits, citrus, polyphagous	Yes
Halticus tibialis	Sweet potato flea mirid	Miridae	Hemiptera	Sweet potato, beans, cucumber	Yes
Helopeltis clavifer	Cocoa mirid	Miridae	Hemiptera	Cocoa	
Heteropsylla cubana**	Leucaena psyllid	Psyllidae	Hemiptera	Leucaena	
Leptocorisa oratorius	-	Alydidae	Hemiptera	Rice	
Maruca vitrata (=M. testulalis)	Bean podborer	Pyralidae	Lepidoptera	Beans, pigeon pea, cowpea	Yes

*Now known to be present – Grahame Jackson (pers. comm.). ** Probably no longer a problem, under biocontrol – Grahame Jackson (pers. comm.).

Table 3 (continued): Major insect pests of agriculture in PNG: very widespread and important (+++)

Species	English common name	Family	Order	Principal crops attacked	PestNet Factsheet
Nisotra spp.	Shot hole beetles	Chrysomelidae	Coleoptera	Aibika	Yes
Oribius spp.	Shot hole weevils	Curculionidae	Coleoptera	Horticultural crops	
Ostrinia furnacalis	Corn borer	Pyralidae	Lepidoptera	Corn, sorghum, sugarcane, ginger	Yes
Pantorhytes sp.	Cocoa weevils	Curculionidae	Coleoptera	Cocoa	Yes
Papuana spp.	Taro beetle	Scarabaeidae	Coleoptera	Taro, sweet potato, oil palm, banana	Yes
Pericyma cruegeri	Poinciana looper	Noctuidae	Lepidoptera	Poinciana	
Phyllocnistis citrella	Citrus leaf miner	Gracillariidae	Lepidoptera	Citrus	Yes
Plutella xylostella	Diamondback cabbage moth	Yponomeutidae	Lepidoptera	Crucifers	Yes
Pseudodioniella pacifica	Cocoa mirid	Miridae	Hemiptera	Cocoa	
Rhabdoscelus obscurus	Sugarcane weevil	Curculionidae	Coleoptera	Sugarcane, coconut, banana	Yes
Rhynchophorus bilineatus	Black palm weevil	Curculionidae	Coleoptera	Coconut	
Riptortus spp.	Bean pod suckers	Coreidae	Hemiptera	Beans, legumes	Yes
Scapanes australis	Scapanes	Scarabaeidae	Coleoptera	Coconut, palms	Yes
Segestidea spp.	Coconut tree hoppers	Tettigoniidae	Orthoptera	Coconut	Yes
Spodoptera litura	Cluster caterpillar	Noctuidae	Lepidoptera	Cabbage, polyphagous	Yes
Haritalodes derogata (= Sylepta derogata)	Aibika (Bele) leafroller	Pyralidae	Lepidoptera	Aibika, okra	Yes

Table 4: Major insect pests of forestry in PNG: widespread and important (++)

Species	English common name	Family	Order	Principal trees attacked
Agrilus viridissimus	-	Buprestidae	Coleoptera	Terminalia brassii
Ceroplastes rubens	Pink wax scale	Coccidae	Hemiptera	Pinus caribaea, Barringtonia
Fabrictilus australis	-	Coreidae	Hemiptera	Araucaria, Eucalyptus, Tectona
Hyblaea puera	Teak moth	Hyblaeidae	Lepidoptera	Tectona grandis, Spathodea
Lymantria ninayi	-	Lymantriidae	Lepidoptera	Pinus patula, P. radiata
Milionia isodoxa	-	Geometridae	Lepidoptera	Araucaria cunninghamii
Pternistria levipes	-	Coreidae	Hemiptera	Tectona grandis
Pternistria macromera	-	Coreidae	Hemiptera	Tectona grandis
Rhyparida coriacea	-	Chrysomelidae	Coleoptera	Eucalyptus deglupta
Unaspis citri	White louse scale, citrus snow scale	Diaspididae	Hemiptera	Toona australis
Xylotrupes gideon	Elephant beetle	Scarabaeidae	Coleoptera	Eucalyptus, Toona, Fraxinus

Table 5: Major insect pests of forestry in PNG: very widespread and important (+++)

Species	English common name	Family	Order	Principal trees attacked
Agrilus opulentus	Varicose borer	Buprestidae	Coleoptera	Eucalyptus deglupta
Coptotermes elisae	-	Rhinotermitidae	Isoptera	Araucaria cunninghamii, A. hunsteinii
Hylurdrectonus araucariae	-	Scolytidae	Coleoptera	Araucaria cunninghamii
Hylurdrectonus pinearis	Hoop-pine bark beetle	Scolytidae	Coleoptera	Araucaria cunninghamii
Hyspipyla robusta	Cedar shoot caterpillar	Pyralidae	Lepidoptera	Swietenia, Toona, Cedrela
Oribius destructor	-	Curculionidae	Coleoptera	Eucalyptus deglupta, Araucaria cunninghamii
Oribius inimicus	-	Curculionidae	Coleoptera	Eucalyptus deglupta, Araucaria, Pinus
Platypus jansoni	-	Platypodidae	Coleoptera	Agathis, Araucaria
Saissetia coffeae	Coffee scale	Coccidae	Hemiptera	Barringtonia
Uraba (=Roeselia) lignifera	-	Nolidae	Lepidoptera	Terminalia
Vanapa oberthuri	-	Curculionidae	Coleoptera	Araucaria cunninghamii
Xyleborus perforans	Island pinhole borer	Scolytidae	Coleoptera	Agathis, Calophyllum, Endospermum, Garcinia, Heritiera, Myristica, Palaquium, Pinus

Fact sheets for important insect pests and beneficials in Papua New Guinea

Examples of **PestNet Pacific Pests and Pathogens Fact sheets** are included here for some of the top insect pests of concern for Papua New Guinea as classified by Waterhouse (1997) and contained in the previous lists.

Beneficial insects

Whilst many insects present pest problems for famers and gardeners, other insects may help and provide complementary solutions to pest control. They are commonly referred to as biocontrol agents or beneficial insects as they will prey (the larvae and or adults) on insect pests living on crop plants. Such beneficials include predatory ladybeetles, lacewings and hoverflies, which all feed on insect pests and should be identified and encouraged to live and reproduce in a healthy crop system.

List of example fact sheets following:

- Bean pod sucking bug (Fact sheet No. 018)
- Cabbage diamond back moth (Fact sheet No. 020)
- Cocoa weevil borer (Fact sheet No. 061)
- Coconut rhinoceros beetle (Fact sheet No. 057)
- Sweetpotato weevil (Fact sheet No. 029)
- Sweet Potato West Indian weevil (Fact sheet No. 119)
- Taro Papuana beetle (Fact sheet No. 030)
- Biocontrols – predatory ladybeetles (Fact sheet No. 083)
- Biocontrols – green lacewings (Fact sheet No. 270)

Further factsheets can be viewed and downloaded as PDF from PestNet (www.pestnet.org).

Bean pod sucking bug (018)

Photo 1. Riptortus nymphs. Note that the nymphs are ant mimics - they have evolved to appear as ants - presumably this makes potential predators cautious about attacking them.

Photo 2. Riptortus adults and nymphs.

Photo 3. Adult Riptorus pod-sucking bug.

Photo 4. Riptortus adult feeding on the seeds of long bean.

Photo 5. Bean pods shrivel and die when attacked by Riptortus, and losses can be high.

Photo 6. Fruit of Bixa, the lipstick tree. Observations on Malaita, Solomon Islands, suggest that Riptortus is attracted to the seeds of this shrub. If proven, it could be used as a companion plant.

Common Name

Pod sucking bug

Scientific Name

Riptortus serripes and Riptortus linearis.

Distribution

Worldwide: It is recorded from Solomon Islands.

Hosts

Legumes, such as long bean, French bean, soybean, and mung bean. Some species attack Macadamia and sorghum.

Symptoms & Life Cycle

Riptortus lays its eggs on bean leaves and other plants; usually the eggs are laid singly. They hatch and the nymphs go through five stages. The nymphs are ant mimics (Photos 1&2), meaning they look like large black ants, presumably to protect them from predation. Adults are dark brown and about 20 mm long (Photos 3&4).

Impact

This is a major pest of beans. Both adult and nymphs "sting" the beans in the pods, feeding on the juices in them, so that the beans fail to mature. The pods turn brown, shrivel and die (Photo 5). Severe damage is caused to bean crops, long beans especially, in Pacific island countries.

Detection & Inspection

Look for the large adult bugs on the leaves and under the leaves, 16-18 mm long; look for ant-like nymphs. Look closely for small holes and damaged, shriveled pods.

Management

NATURAL ENEMIES

There are no reports of predators or parasitoids attacking Riptortus in Pacific island countries. However, the reduviids (assassin bugs), mantids (preying mantids), spiders and wasps that are known to attack Leptoglossus (**see Fact Sheet no. 165**) probably attack Riptortus eggs, and prey on nymphs.

CULTURAL CONTROL

Before planting:

- Do not plant crops of beans next to those that are already infested with the bug.
- Plant beans next to Bixa (Photo 6), a method recommended by a farmer on Malaita, Solomon Islands. Bixa is known as the lipstick tree. It has deep red, soft, seeds that children use to paint their faces, lips included. Bixa acts as a trap crop. As the seeds open large numbers of Riptortus are attracted to the seeds, preferring them to the seeds of beans, which suffer less damage as a consequence.

During growth:

- Handpick the insects. Do this in the early morning, as at other times of the day the insects are more likely to take flight.

After harvest

- Collect and burn as much of the crop as possible after harvest.

CHEMICAL CONTROL

If infestations reach levels where chemical control is necessary, use sprays of derris, pyrethrum or chilli. If a commercial product is needed, use synthetic pyrethroids or malathion.

AUTHORS Helen Tsatsia & Grahame Jackson
Photos 1&2 Graham Teakle, Canberra, Australia.

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Cabbage diamond back moth (020)

Photo 1. At first, the caterpillars of diamond backed moth, Plutella xylostella, eat from the underside of the leaf to the top layer of wax.

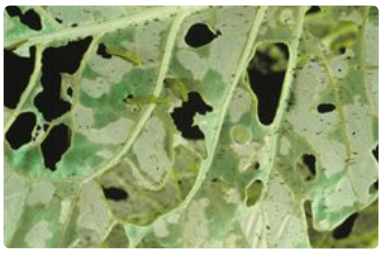

Photo 2. Holes in the leaf caused by larvae of diamond back moth, Plutella xylostella.

Photo 3. Pupa of diamondback moth, Plutella xylostella.

Photo 4. Adult diamond back moth, Plutella xylostella, showing the characteristic wing patterns.

Common Name

Diamond back moth, diamondback moth

Scientific Name

Plutella xylostella

Distribution

Worldwide. It is recorded in Fiji, Samoa, Solomon Islands, and Tonga.

Hosts

Members of the cabbage (brassica) family, e.g., head cabbage, Chinese cabbage, radish, cauliflower and broccoli; Amaranthus and watercress.

Symptoms & Life Cycle

The caterpillars do the damage. The first two stages are small and feed by mining the leaf; later, when they are too large to mine, they burrow through the leaf. The result is 1-2 cm wide cavities on the lower leaf surface leaving the waxy layer intact, which gives the appearance of windows in heavily damaged plants (Photo 1). Later, the caterpillars eat through the leaf (Photo 2).

The eggs are small (0.4 mm long), cylindrical or oblong, white when laid, changing to yellowish brown as they mature and ready to hatch. The eggs are mostly laid singly or in groups of two or three, on the lower leaf surface along major veins. One adult female lays 100-150 eggs in a life span of 3-7 days. The incubation period ranges from 3-8 days depending on the temperature.

There are four larval or caterpillar stages. At hatching, the caterpillars are grey-green; later, when fully grown, they are dark

green and approximately 12 mm long (Photos 1&2). When disturbed, the larvae wriggle backwards, and may drop from the leaf on a silk thread. The larval period ranges from 14-28 days, after which they make a silken cocoon and pupate (Photo 3).

The pupa is dark green or light brown, about 10 mm long, and usually stuck to the underside of the leaf. Pupation lasts 5-10 days.

After pupation, the adult moth emerges from the cocoon. It is about 10 mm long with a 13 mm wingspan, dark brown with three white diamond-shaped patterns on its back; these give the moth its common name (Photo 4). The adult lives for up to 35 days.

The life cycle is complete in less than 1 month (14 days at 25^{o}C), depending on the temperature. The moth is most active at night.

Impact

Economic damage is most severe when heading begins. The caterpillars tunnel into the heads of cabbages. The diamond back moth is the most destructive insect pest of brassica crops throughout the world. Worldwide, the management of the annual damage caused by this insect has been estimated to be US$4-5 billion!

Note: other pests often occur on ball cabbages along with this moth, and the combined damage is considerable. The other pests are cabbage webworm, Hellula undalis (see Fact Sheet no. 114); cutworm, and cabbage cluster caterpillar, Spodoptera litura; or large cabbage-heart caterpillar, Crocidolomia pavonana (see Fact Sheet no. 78).

Detection & Inspection

It is very important to monitor the start of diamond back moth infestations by:

- Visiting the field everyday, looking for any adults or larvae on the plants.
- Putting yellow sticky traps in the field to catch flying adults.
- Putting sticky traps baited with diamond back moth sex pheromone to trap male adults.

Look for larvae (caterpillars) that are pale green, slightly tapered at each end and grow through four stages to a length of about 12mm. They have a dark head in the first two stages. They wriggle when disturbed, often dropping from the plant on a silken thread. Look for the moth with a diamond pattern on the back.

Management

NATURAL ENEMIES
There are several parasitioids of the different stages: eggs - Trichogrammatoidea bactrae; caterpillars - Cotesia plutellae, Diadegma semiclausum, Microplitis plutellae, Oomyzus sokolowskii; pupae - Diadromus collars.

CULTURAL CONTROL

Before planting:

- Always start with healthy, insect-free seedlings.
- Grow head cabbages during the cooler times of the year (June-November) to avoid infestations.
- Grow collard greens (Brassica oleracea), mustard (Brassica juncea) or Chinese cabbage (Bok Choy) as trap crops. Trap crops for the other species are: (i) radish and green mustard (Brassica juncea) for Hellula undalis; (ii) Chinese cabbage (B. pekinensis cv. Tempest) or flowering green mustard for Crocidolomia pavonana. (Note that the latter is also useful as a trap crop for Halticus tibialis). The companion crop is planted between rows of cabbages and other Brassica species. Plant a first row of the companion plant about 15 days before transplanting the cabbages, and a second row about 25 days after transplanting. The idea is to destroy the trap crop before the insects hatch.
- Where farmers have the resources, grow plants under nets or in screenhouses.

During growth:

- Handpick larvae when numbers are low.
- Destroy crucifer weeds before planting and during the cropping period.
- For watercress grown on rafts in the river (Solomon Islands), sink one half for 30 minutes to drown the caterpillars, and

then do the same for the other half. Drowning one half of the plants, then the other half, is done so that spiders are able to survive. Spiders are natural enemies of the diamond back moth caterpillars.

- Monitor the crop regularly, looking for eggs and recently hatched caterpillars.

After harvest:

- Collect and destroy crop debris after harvest.

CHEMICAL CONTROL

If pesticides are used, there is need for careful choice. If one chemical is used all the time, it is likely that the diamond back moth will develop resistance to it. Do the following:

- Use plant-derived products, such as neem, derris, pyrethrum and chilli (with the addition of soap), or synthetic products that contain disease-causing organisms, such as spinosad (Success) and Bt - Bacillus thuringiensis subspecies kurstaki (Dipel).
- If using Dipel:
  - Apply when the caterpillars are at an early stage of development.
  - Spray in the late afternoon or early evening, when the caterpillars are actively feeding and when the effect of UV on Dipel will be less.
- Two synthetic products with different modes of action are indoxacarb (Steward) and chlorantraniliprole (Prevathon). They should be used only when necessary (i.e., when there is likely to be economic damage to the crop), each should be applied only once during the pest's lifecycle and they should be alternated to slow the development of resistance.

AUTHORS Helen Tsatsia & Grahame Jackson
Photos 1&2 Graham Walker, Plant and Food Research, Auckland, New Zealand. Photo 3 Richard Markham, ACIAR, Canberra. Photo 4 Jack Kelly Clark, US Statewide IPM Project.

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Cocoa weevil borer (061)

Photo 1. Grub or larva of cocoa weevil borer, Pantorhytes sp.

Photo 2. Adult cocoa weevil borer, Pantorhytes sp.

Photo 3. Adult cocoa weevil borer, Pantorhytes sp., damage to cocoa pod.

Photo 4. Crazy ant, Anoplolepis gracilipes.

Photo 5. The weaver ant, Oecophylla smaragdina, on a cocoa pod colonised by mealybugs.

Common Name

Cocoa weevil borer

Scientific Name

Pantorhytes species. At least 13 species are recognised a pests of cocoa, most of them from Irian Jay and Papua New Guinea. Pantorhyte biplagiatus is a serious pest of cocoa in Solomon Islands. It is described here.

Distribution

Limited distribution. Indonesia, Papua New Guinea, the Philippines and Solomon Islands.

Hosts

Cocoa and several commercial forest trees, e.g., Eucalyptus and Terminalia.

Symptoms & Life Cycle

The white, oval eggs, about 2 mm long, are laid singly in crevices in the trunk and main branches, particularly near the main fork or "jorquette". They hatch after 2-3 weeks. The larvae bore into the wood (Photo 1), feeding for 3-9 months through nine instars, and then pupate beneath the bark for about 2 weeks.

The adults are black and red (Photo 2), wingless weevils about 1.5 cm long. They feed for 4-6 weeks before mating; afterwards,

the female lays about two eggs a day throughout a life of 1-2 years. Adults feed on the bark of young cocoa shoots, flowers and, occasionally, pods (Photo 3), but the damage is not sufficient to affect pod production.

Impact

The larvae do the damage. They bore into the sapwood of trunks and branches, making tunnels 1-3 cm deep. Often the tunnels are made at or near the jorquette, the junction of branches and the trunk. Damage at the jorquette has the potential to weaken trees, causing tip dieback, death of branches, and even death of the tree if splits occur there. Consequently, pod yields may be reduced considerably.

The wounds made by larvae may allow entry of the bark canker water mould, Phytophthora palmivora (see Fact Sheet no. 06), and also termites.

Detection & Inspection

Look for holes in the trunk and branches, particularly at the jorquette; look for the jelly-like substance that exudes from the holes where the larvae feed. Look for the adult beetles, that have a red abdomen with white spots, and are relatively slow moving, sufficient to be handpicked.

Management

NATURAL ENEMIES

Biocontrol of Pantorhytes is possible using the crazy ant, Anoplolepis gracilipes (Photo 4), or Oecophylla smaragdina (Photo 5). Both these ants make colonies in soursop trees, so these should be planted between cocoa trees to encourage them. They also nest in the crown of coconuts feeding off honeydew-producing scale insects. The little fire ant, Wasmannia auropunctata, too, may be antagonistic to Pantorhytes, although this should not be intentionally introduced into cocoa plantations because of its painful bite.

The yellow-brown crazy ant has long legs and antennae (Photo 4). Its total length is about 4 mm. It kills its prey by spraying formic acid. Wasmannia is smaller.

CULTURAL CONTROL

- Handpick Pantorhytes adults (they do not have wings) during the middle of the day when they come down from the canopy to find cooler places.
- Routinely inspect trees for tunnels made by the larvae, and kill them with a piece of wire.
- If possible, plant cocoa under the shade of coconuts, forest trees, Leucaena or Gliricidia; possibly, the lower numbers under coconuts are associated with higher ant populations.

CHEMICAL CONTROL

The use of insecticides - other than as a "paint" to kill larvae - is not recommended. Its difficult to bring chemicals into contact with the larvae inside their tunnels, and the low population of beetles makes their use uneconomic. The best method for large and small plantations is to inspect and kill the larvae as explained above. However, if chemical control is required, perhaps in severely infested plantations, do the following:

- Find the larvae by looking for frass pushed out of the entrance of the larval tunnel and/or a jelly-like substance.
- Remove the frass with a stiff brush and apply a solution of Orthene (acephate), white oil, Ridomil (metalaxyl) (or phosphorus acid), and water with a small 2 cm brush onto the bark around the entrance hole. (Metalaxyl or phosphorus acid is added to control Phytophthora). Repeat after 2 weeks, and continue to monitor the trees.

AUTHORS Helen Tsatsia & Grahame Jackson

Photo 4 Global Invasive Species Database (http://www.issg.org/database/species/ecology.asp?si=110).

Produced with support from the Australian Centre for International Agricultural Research under project PC/2010/090: Strengthening integrated crop management research in the Pacific Islands in support of sustainable intensification of high-value crop production, implemented by the University of Queensland and the Secretariat of the Pacific Community.

Coconut rhinoceros beetle - Melanesian (057)

Photo 1. Scapanes australis third stage larvae.

Photo 2. Scapanes australis, male.

Common Name

Melanesian rhinoceros beetle, coconut rhinoceros beetle, Scapanes

Scientific Name

Scapanes australis. Different sub-species (Scapanes australis australis and Scapanes australis grossepunctatus) exist in Papua New Guinea; the situation in Solomon Islands has not been studied.

Distribution

Restricted; Southeast Asia, Papua New Guinea and Solomon Islands.

Hosts

The main hosts are coconut, oil palm and betel nut, but the beetle is also found on banana, sugarcane and wild palms.

Symptoms & Life Cycle

The adults bore into crowns of coconut, oil palm and other palm species, as well as pseudostems of bananas. Damage to coconuts is considerable, especially up to 5 years' old. The emerging fronds show V-shaped cuts, twisting, spiraling and truncated leaflets. If the growing point is damaged, the palms die. The damage allows entry of other organisms: termites and, especially, Rhynchophorus weevils.

The eggs are creamy-white, about 5 mm long and 3 mm diameter, laid singly in soil near rotting logs or other decaying matter that provides food for the larvae. In Papua New Guinea, breeding sites occur in cocoa and coconut plantations associated with rotting stumps of shade tree (e.g., Gliricidia sepium). Breeding sites have also been found in old nests of magapodes, when these were near breadfruit trees.

Eggs hatch after about 30 days producing C-shaped larvae (Photo 1), with heads of reddish-brown to brown. As the larvae grow, they moult twice, reaching 10 cm in length and 2 cm wide, before pupating at about 9 months. Adults are black, 4-6 cm long, and are strong fliers. Males are horned (Photo 2) while females have small double horns on their heads. Adults live for about 4 months. Males and females have been seen in the same tunnel in the crown of a coconut, but it is the male alone that is seen most commonly.

Impact

Damage can be severe when coconuts are planted in land cleared from forest, where the rotting logs provide breeding sites. All the palms may be damaged within 5 years, discouraging farmers from planting or replanting coconuts. However, as the logs rot away, and there are less breeding sites, the attack decreases.

Detection & Inspection

Look for the larvae beneath rotting logs. However, for correct identification, they need to be bred to adults, as they are similar to other beetles in the scarab family. Keep them in a sterilised cow dung and sawdust mixture. Look for the horns on the adult male beetles, they are characteristic, whereas females may be more difficult to recognize.

There could be confusion with Oryctes rhinoceros, but that attacks much older palms.

In the field, inspect the crown of the palms, looking for V-shaped cuts in the leaves, distorted fronds and fibre pushed from the tunnels into the crown. Follow the tunnel to find the beetle.

Management

Control of Scapanes is difficult as they can cause substantial damage even though the numbers of adult beetles per hectare is relatively low.

NATURAL ENEMIES

As Waterhouse and Norris say in Biological Control Pacific Prospects, "Scapanes is not an attractive target for biological control". It is mainly a grower-made problem due to planting coconuts in recently cleared forests. There have been no attempts at biological control although Scapanes is susceptible to Oryctes rhinoceros nudivirus which has been used against Oryctes rhinoceros. Its success against Scapanes is limited by the dispersed distribution of the larvae.

CULTURAL CONTRO

Before planting:

- If possible replant coconuts within existing coconut plantations, where it might be expected that potential breeding sites for Scapanes would be low.
- Remove or burn breeding sites, large logs in particular (a difficult practice for small holders when clearing sites from forest).
- Plant Pueraria phaseolodes, Mucuna pruriens or other legume species as soon as the trees have been felled to cover the logs and stumps in order to interrupt egg laying.

RESISTANT VARIETIES

Fast-growing varieties are more likely to outgrow the damage caused by the beetles. In Papua New Guinea, fewer palms of the Gazelle Tall died from attack compared to Rennell Tall or Malayan Dwarf.

CHEMICAL CONTROL

Chemical control of this pest is very difficult and not recommended under small-scale production systems.

A pheromone has been isolated and used in mass trapping trials in Papua New Guinea. It is said to be easy to make and is cheap. It attracts both males and females. It has still to be put to use in estate and smallholder plantations.

Previously, granular insecticides were placed in the axils of the fronds. Lindane (HCH) and Furadan (carbofuran) have been used in the past, but the production and use of these chemicals is restricted or banned in many countries. Recommendations for alternatives should be sought from government authorities.

AUTHORS Helen Tsatsia & Grahame Jackson

Information from Waterhouse DF, Norris KR (1987) Biological Control Pacific Prospects. Inkata Press. Photos 1&2 L. Beaudoin-Ollivier, CABI (2010) Scapanes australis (rhinoceros beetle) Crop Protection Compendium (www.cabi.org/cpc).

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Sweetpotato weevil (029)

Photo 1. Larvae or grubs of sweetpotato weevil, Cylas formicarius, damaging a vine at the crown where the stem enters the ground.

Photo 2. External damage to the base of the vine - called the crown - by the sweetpotato weevil, Cylas formicarius. Holes used by the adults to exit the stems can be seen.

Photo 3. Crown area of the vine, just above soil level, heavily infested by sweetpotato weevil, Cylas formicarius, and rots have developed.

Photo 4. Larvae or grubs of sweetpotato weevil, Cylas formicarius, in a storage root.

Photo 5. Adult sweetpotato weevil, Cylas formicarius.

Photo 6. Adult sweetpotato weevil, Cylas formicarius, caught in a sticky trap.

Photo 7. sweetpotato weevil, Cylas formicarius, on the outside of a storage root left on the soil. Note the small feeding pits made by the weevil.

Photo 8. A pheromone trap attracting large numbers of male sweetpotato weevils, Cylas formicarius. Note the trap is a plastic bottle with the top 1/3 cut off and inverted. The pheromone has been absorbed onto rubber tubing which is held in place by wire.

Common Name

Sweetpotato weevil

Scientific Name

Cylas formicarius

Distribution

Worldwide. It is recorded from Fiji, Samoa, Solomon Islands, and Tonga.

Hosts

Sweetpotato (Ipomoea batatas), and many types of morning glory.

Symptoms & Life Cycle

Damage is done by the adult beetles and grubs or larvae. The adults feed on the buds, leaves, vines and storage roots. However, grubs cause most damage by tunnelling through the stems (Photos 1-3) and storage roots (Photo 4). In the storage roots, tunnelling produces chemicals called terpenes, which give the flesh an unpleasant taste.

Female beetles lay eggs singly in the base of the vines, or crawl through cracks in the soil to lay eggs in the storage roots. The eggs are white, oval, and about 0.5 mm long. They are sealed in with a protective grey faecal plug. Several hundred eggs are laid over a lifespan of about 4 months.

The grubs are legless, white, with a brown head and reddish-brown gut. At maturity, the grubs are up to 8 mm long; they then pupate. Pupae are creamy white, up to 6 mm long. This stage lasts about a week. After coming out of the pupa, the adult beetle stays in the tunnel for about a day before cutting through to the outside.

Adult weevils are small and ant-like (Photos 4&5). They are 5-7 mm long, with a smooth and slender body and snout. Their head and rear are metallic blue or black, and their middle, legs and antennae are red. The full lifecycle takes just over a month. The adult weevils feed on the leaves, vines and storage roots, but do little damage. On the storage roots they make small shallow pits as they feed (Photo 7).

Impact

Sweetpotato weevil is considered to be the most serious pest of sweet potato, with reports of losses ranging from five to more than 80%. Losses increase the longer the crop remains in the ground unharvested. The impact on yield depends to a great extent on the soil and weather. Light sandy soils and low rainfall increase the chances of heavy infestations. There is also evidence that red-fleshed low dry matter varieties are more susceptible to infestation.

Detection & Inspection

Look at the base of the plant for small holes and damage to the stem. Break the stem to see if there are tunnels, rots and larvae. Dig up a storage root and look for damage to the skin, and feeding tunnels of the larvae inside. Adult beetles are most active at night, but can sometimes be seen on plants during the day. A pheromone is available which attracts male weevils (Photo 8). It is useful for estimating the relative number of weevils in any location.

Management

QUARANTINE

The unrestricted movement of plant propagating material (cuttings, shoots and storage roots) has the potential of further spreading the weevil, and should be done with caution. The FAO/IBPGR Technical Guidelines for the Safe Movement of Sweet Potato Germplasm (http://www.bioversityinternational.org/e-library/publications/detail/sweet-potato/) should be followed.

NATURAL ENEMIES

Predatory ants, beetles, spiders and earwigs attack adult weevils. Tiny wasps attack them too. They also become infected by Beauveria, a fungus. Bacteria and nematodes kill the grubs. However, none of these organisms appear to make significant reductions in the weevil populations.

BIOLOGICAL CONTROL

The fungus, Beauveria bassiana, is produced in large quantities and used intensively for the control of sweet potato weevil in Cuba. Sprays of the fungus have largely replaced the use of chemical insecticides. Also in Cuba, predatory ants (Pheidole megacephala, the big-headed ant) have been used effectively to control weevils. Research on both these potential biological control organisms is being done in Papua New Guinea.

CULTURAL CONTROL

Before planting:

- Choose short-season varieties, i.e., those that produce a crop early. Note that PT (pathogen-tested) varieties without

virus infections are likely to give early and high yields.

- Avoid planting sweet potatoes in the same area 2 years in a row, and plant well away from infested crops. Grow sweet potatoes in the same field only once every 3-4 years.
- Select "clean" cuttings (25-30 cm long) from fresh young growth to reduce the spread of weevils.
- Use varieties which set their roots deep in the soil, and/or plant vines deeply.

During growth:

- Hill-up around the plants, to cover any cracks that have appeared in the soil. Weevils usually access roots via cracks in the soil. Also, prevent cracking by spreading mulch to keep the soil moist.
- Harvest the crop as soon as it has developed sizeable roots.

After harvest:

- Destroy crop residues left in the field after harvest, as weevils survive in discarded storage roots and also in the stems of harvested vines. This is THE most important part of the management of this pest.

CHEMICAL CONTROL
These recommendations are for commercial growers; those selling their produce in markets where signs of weevil damage would affect acceptability and price.

- Treat vine cuttings with insecticides to kill weevils and prevent infestation in new plantings. This is a better use of insecticides than blanket sprays, especially if combined with proper sanitation and the other measures listed under cultural control.
- Inspect the crop regularly, at least once a week: check the base of the vines, looking for damage and holes.
- Ideally, use the male pheromone to monitor weevil populations (if available). A commercial product is added to rubber tubing and placed in a trap (Photos 6&8). (A pheromone is a chemical released by insects to bring the sexes together. In this case, the pheromone produced by the female weevil has been made artificially.)
- Spray with insecticide (e.g., bifenthrin or fipronil) if damage occurs at the crown area of the vines (i.e., the part just above ground level). Spray routinely with bifenthrin or fipronil, every 3-4 weeks. Follow the manufacturer's directions on the label.

AUTHORS Helen Tsatsia & Grahame Jackson
Photos 1,4,5,6&8 Russell McCrystal, Bundaberg, Queensland.

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Sweetpotato West Indian weevil (119)

Photo 1. Adult West Indian sweetpotato weevil, Euscepes postfasciatus, showing distinctive white patches on the wing case.

Photo 2. Adult West Indian sweetpotato weevil, Euscepes postfasciatus, showing typical weevil snout, and part of the distinctive white patch on the wing case. The body is covered in short stiff hairs.

Common Name

West Indian sweetpotato weevil

Scientific Name

Euscepes postfasciatus

Distribution

Widespread in the Caribbean, Central and South America, and with a restricted distribution in the USA (California and Hawaii), and Asia (Japan). It is widespread in the Pacific islands, and recorded from Fiji, Samoa, and Tonga.

Hosts

Sweetpotato, and wild relatives in the genus Ipomoea.

Symptoms & Life Cycle

The larvae or grubs do the most damage, and this is similar to that caused by the sweetpotato weevil,Cylas formicarius. The larvae tunnel through the base of the stem (crown) and through the storage roots. In the storage roots, tunnelling produces chemicals called terpenes, which give the flesh an unpleasant taste. The adults also feed on the shoots and young stems, but the damage is small compared to that on storage roots and crown.

The eggs are round, yellowish, laid singly in pits in the stems (always at the nodes, the junction of stems and petioles) or in storage roots. After laying the eggs the pits are sealed with a faecal plug. Storage roots are preferred to stems. The eggs hatch in about 10 days, and the legless grubs moult four times over the next 20-30 days, reaching a length of about 8 mm. The pupae are white, about 5 mm long. After another 10 days the adults emerge. They leave the storage roots and stems by chewing exist holes. Adults are 3.5-4 mm long and 1.5 mm wide, reddish brown to greyish black, covered with stiff hairs, with two white patches on the wing cases (Photos 1&2); they are thought to live for about 6 months.

There is no evidence that the weevils spread by flying; however, this needs to be checked. It is more likely that they crawl short distances from weedy borders, and are spread longer distances in cuttings and in storage roots used for planting. Hot and dry weather favours weevil development. At 27-30° C, the life cycle takes about 30 days.

Impact

There is little information on the damage caused by this weevil, compared to that done by Cylas formicarius (see Fact Sheet no. 029). However, in Papua New Guinea is appears to be more common in the storage roots than Cylas, in both highland and lowlands areas. As Euscepes is common in other Pacific island countries, the damage done by this weevil needs verified.

Detection & Inspection

Look at the base of the vine (called the crown) for small holes and damage to the stem. Break the stem to look for tunnels, rots and larvae. Dig up a storage root and look for damage to the skin, and feeding tunnels of the larvae inside. Detection of early infestation is not easy as adults are most active at night, and they pretend to be dead when disturbed.

Management

QUARANTINE

The unrestricted movement of plant propagating material (cuttings, shoots and storage roots) has the potential of further spreading the weevil, and should be done with caution. The FAO/IBPGR Technical Guidelines for the Safe Movement of Sweet Potato Germplasm (http://www.bioversityinternational.org/e-library/publications/detail/sweet-potato/) should be followed. Note, the weevil has not been recorded from Solomon Islands.

NATURAL ENEMIES

Little is known about natural enemies. Infections from the fungus Beauveria sp. are reported from Peru and Japan. However, the weevil causes greatest damage during dry weather, so strains of Beauveria are needed that persist and are pathogenic during such times. In Cuba, nests of ants (e.g., Pheidole, the big-headed ant) are put in gardens in rolls of banana leaves to control weevils.

CULTURAL CONTROL

Cultural control methods offer the best chance of reducing populations of the weevil to acceptable levels. Hygiene measures and the use of cuttings free from adults and eggs are two of the most important cultural control strategies:

Before planting:

- Choose short-season varieties, i.e., those that produce a crop early. Note that PT (pathogen-tested) varieties without virus infections are likely to give early and high yields.
- Always choose tip cuttings for planting, 25-30 cm long, taken from young shoots.
- Use varieties which set their roots deep in the soil, and/or plant vines deeply.

During growth:

- Remove alternate hosts, i.e., wild Ipomoea species, from around the field.
- Hill-up, i.e., cover exposed storage roots and cracks with soil; it is important to do this. Remember, weevils do not burrow; they reach storage roots through cracks in the soil.
- Ideally, harvest all the storage roots at one time.

After harvest:

- Remove and destroy infested vines and storage roots immediately after harvest.
- Do not plant sweetpotato on the same land continuously; rotate with other crops leaving a gap of at least 3-4 years between crop of sweetpotato on the same land.

RESISTANT VARIETIES

None have been reported, although germplasm collections, such as that at the International Potato Center (CIP), Peru, have been screened for resistance.

CHEMICAL CONTROL

- Before planting: Treat vine cuttings with insecticide (e.g., bifenthrin) to kill weevils and prevent infestation of new plantings. Inspect the crop regularly, at least once a week: check the base of the vines, looking for damage and holes.
- After planting:
  - Spray with insecticide (e.g., bifenthrin or fipronil) when numbers reach a level that is known to result in lower yields. For instance, in Japan, plants are sprayed if 5% of stems are damaged by 75 days. Experience tells that exceeding this level of damage will result in lower yields.
  - Alternatively, spray routinely with bifenthrin or fipronil every 3-4 weeks.

AUTHOR Grahame Jackson

Information from CABI (2014) Euscepes postfasciatus (West Indian sweet potato weevil) Crop Protection Compendium (**www.cabi.org/cpc**). Photos 1&2 Gerald McCormack, Cook Islands Biodiversity & Natural Heritage (http://cookislands.bishopmuseum.org/).

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Taro Papuana beetle (030)

Photo 1. Extensive and typical damage caused by taro beetles, Papuana sp., in taro corms. These corms are unmarketable.

Photo 2. Damage in a taro corm due to the feeding of taro beetles, Papuana sp.

Photo 3. Adult taro beetle, Papuana sp. The beetle is about 20 mm long.

Common Name

Taro beetle, Papuana beetle

Scientific Name

Papuana species. There are 18 species in Papua New Guinea, 11 of which damage taro; common species are: Papuana woodlarkiana, Papuana huebneri, Papuana trinodosa, Papuana biroi, Eucopidocaulus tridentipes and Papuana szentivanyi.

Distribution

The beetles are native to Asia (Indonesia) and Melanesia. Apart from Papua New Guinea, they are present in Fiji (one species) and Solomon Islands (six species).

Hosts

Common hosts of Papuana beetles are seedlings of oil palm and coconut, Alocasia (giant taro), banana, Cryrtosperma (giant swamp taro), sugarcane, Pandanus and taro.

Symptoms & Life Cycle

Adult beetles do the damage by burrowing into the underground parts of their hosts (Photos 1&2).

The adult is a shiny black beetle, 15-25 mm long (Photo 3). The beetles have horns on the head, but the number and size differs among species. Those of the male are generally larger. Eggs are laid about 7 weeks after the female emerges from the soil. The eggs are laid singly; they are white, oval and 2-3 mm long. Grubs emerge after about 2 weeks. These are white, and C-shaped at rest. They moult three times and when mature are 25-40 mm long. At about 90 days they pupate for 3-4 weeks before the adult emerges. The entire life cycle takes 4-5 months.

Male beetles are less mobile: they colonise the taro corms, awaiting the arrival of females. After mating, the female flies to find a breeding site, usually places with decaying organic matter, e.g., rotten logs/stumps, manure, saw dust, along river banks and in the fibrous roots of grasses. Each female lays up to 300 eggs during a lifespan of about 20 months. The adults are capable of flying up to a kilometre, and they are attracted to lights.

When the forest is disturbed, for instance due to logging or cyclones, Papuana beetles are common in taro gardens. In the forest, ferns (Angiopteris species) are a common host.

Impact

Oil palm and coconut seedlings, and taro wilt and die when the tunnels reach the growing point. More commonly, plants

remain alive, but grow poorly. Holes bored in the corms of taro make them unfit for market, and where damage is considerable they are not even fit for home use.

Estimates of the amount of damage are hard to come by, but in Papua New Guinea it is put at about 15%, with losses as high as 80% in individual gardens. In many parts of Solomon Islands, taro is very difficult to grow because of Papuana beetles, and they are one of the reasons why farmers have abandoned the crop. This is serious, because loss of taro means a loss of genetic diversity, and this may impact food security. It may also undermine cultural traditions, many of which are dependent on taro.

Detection & Inspection

Look for young oil palm, coconut and taro that are wilting. Pull up to check if Papuana beetles are present. Use light traps to catch the beetles, and sample potential breeding sites for the grubs (compost heaps, sawdust, rotting logs) and wild hosts, such as grasses (Paspalum species and Brachiaria mutica), bananas ferns and sugarcane.

Management

NATURAL ENEMIES

Several natural enemies have been recorded, including the fungus Metarhizium, a tachinid fly and the cane toad, but none are considered effective in controlling populations sufficiently well to stop corm damage.

BIOLOGICAL CONTROL

Although much work has been done using the fungus Metarhizium anisopliae, and it has been shown to work under experimental conditions, there is no recommendation as yet for farmers. It is difficult for farmers to maintain stocks of the fungus, which has to be grown on rice grains and applied to each planting hole, as well as likely breeding sites.

The virus that infects Oryctes rhinoceros, the dynastid beetle of coconuts, has been tried against Papuana, but without success.

CULTURAL CONTROL

Several cultural control measures have been suggested, including crop rotation, clean planting material (i.e., free from soil and beetles), and destruction of breeding sites near gardens, but these are impractical, and are unlikely to be effective, even if farmers tried to implement them.

Recently, there has been interest in the use of cover crops. There is evidence that planting taro into a mulch formed by a legume cover crop keeps taro relatively free from Papuana beetles. Whether this is a physical barrier, or some other reason is not known. The legume Mucuna is the cover crop with greatest potential as it grows vigorously, and is an annual. But Pueraria phasioloides and other ground legumes may be just as effective.

CHEMICAL CONTROL

Use imidacloprid (sold under the trade name of Confidor), or cypermethrin a pyrethroid (Mustang); both are effective in controlling Papuana beetles in Fiji, and in trials in Solomon Islands. To control Papuana beetle, 125 mL of a 1.5 mL/L solution of imidacloprid is applied to the planting hole at planting and at 3 months.

AUTHORS Helen Tsatsia & Grahame Jackson

Photo 2 Graham Teakle, Canberra. Photo 3 Sada N Lala Taro beetle management in Papua New Guinea and Fiji. Secretariat of the Pacific Community.

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Biocontrols - predatory ladybeetles (083)

Photo 1. Ladybeetle larva.

Photo 2. Ladybeetle larva.

Photo 3. Ladybeetle larvae feeding on aphids. Ants are also present taking the honeydew from the aphids.

Photo 4. Ladybeetle larvae feeding on aphids. The pale yellow slug-like creatures in the centre and to the right are larvae of syrphids or hoverflies.

Photo 5. Adult ladybeetle.

Common Name

Ladybeetles, ladybird beetles

Scientific Name

The one shown is Phrynocaria sp; there are many others.

Prey

Aphids, mealybugs, scale insects, caterpillar eggs, mites.

Distribution

Lady beetle species of many different types are present in all the Pacific island countries.

Symptoms & Life Cycle

Eggs are generally yellow and the shape of rice grains; they are laid on their ends in clusters, close to aphid colonies. The larvae hatch at the same time; they look like miniature crocodiles (Photos 1-4). They have spots or patches of dark blue, with areas of red or yellow. After several weeks of feeding the larva attaches to a leaf or a branch, and turns into a pupa. The pupa looks like a curled up larva, with similar colours. About a week later, the pupa splits and the adult crawls out. As the skin starts to dry and harden, the adult becomes characteristically yellowish-orange with black markings (Photo 5).

The larger species, feeding on aphids and insect eggs, are bluish-black and red or yellow; the smaller species, feeding on scale insects, are white with long waxy threads.

Impact

Ladybeetles do not damage crops: they are not pests. Predatory ladybeetles are beneficial; they occur on many crops, feeding on aphids, mealybugs, scales and other damaging insect pests.

It is important to distinguish predatory or "farmer-friendly" ladybeetles from the plant-feeding ladybeetles belonging to the subfamily Epilchninae (**see Fact Sheet no. 58**). The adult plant-feeding ladybeetles have short soft hairs on the upper surface, and the larvae have long stiff spines over the body.

Detection & Inspection

Look for adult ladybeetles with bright shiny, round bodies, which are red or orange with black markings or spots, without soft short hairs; look for the eggs, which are creamy yellowish-orange, laid in clusters close to aphid colonies; and look for the larvae, which are long, active, dark with yellow or red spots and patches, and covered in branched spines.

Management as Biocontrol Agents

GENERAL
Ladybeetles are effective biological control agents, but will only appear in the crop if there is food for them, such as aphids or scales. Pesticides easily kill them, and routine spray programs will destroy any ladybeetles feeding on insect pests and mites.

MOVING THEM AROUND
As all stages of ladybeetles are relatively large, it is easy to move them to where they would do most good. Handpick adults and larvae, and pluck leaves with eggs and pupae and place them in a collecting (jam) jar. Transfer the contents of the jar onto the crop plants infested with pest species.

PROVIDING THEM WITH FOOD
Garden flowers and weeds provide ladybeetles with sugar from their nectar or pollen. Growing flowering plants in the field and around the edges will encourage ladybeetles to stay in the fields to breed. Basil and marigolds are useful garden flowers. Sonchus (sow thistles) and Chenapodium (goosefoots) are weeds that are particularly good sources of food for ladybeetles, providing nectar and pollen as well as aphids.

THE DANGERS FROM USING PESTICIDES
Pesticides are harmful to ladybeetles and should only be considered for control of aphids and other pests if ladybeetles are absent or in low numbers. If pesticides are needed, use ones that stay active on plant surfaces for a few days only. For example, use derris, pyrethrum, or synthetic pyrethroids. These are destroyed rapidly by sunlight.

AUTHORS Suzanne Neave & Grahame Jackson
Photos 1,3&5 Suzanne Neave, CABI, UK.

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Biocontrols - green lacewings (270)

Photo 1. Green lacewing adult, Chrysoperla sp.

Photo 2. Brown lacewing adult, Micromus sp.

Photo 3. Group of lacewing eggs, Chrysoperla sp., fastened to a side of a branch.

Photo 4. Larva of a green lacewing. Note the stiff hairs along the sides, and the protruding pincer-like mouth parts.

Common Name

Lacewings. There are two kinds: green (Photo 1) and brown (Photo 2). Green lacewings are more common and are also called "common lacewings" or "common green lacewings". The two types, green and brown, not only differ in colour, but also in the venation of the wings. In this fact sheet we are dealing with green lacewings.

Scientific Name

Green lacewings belong to the family Chrysopidae. Brown lacewings belong to the family Hemerobiidae. Two common genera of green lacewings are Chrysoperla and Chrysopa.

Prey

Both the adults (of some species) and the larvae prey on soft, sap-sucking insects, such as aphids, scale insects and many other insects (see under Impact).

Distribution

Worldwide. Recorded from Fiji and Samoa.

Symptoms & Life Cycle

Many species of green lacewings lay their eggs on thin stalks, singly or in batches (Photo 3), attached to the underside of leaves, wood, or the sides of buildings. Female lay up to 300 eggs over 3-4 weeks. After hatching, the larvae moult several times. When mature, they have long (up to 15 mm) narrow flattened bodies with stiff hair-like projections (Photo 4). They have

chewing mouthparts, with pincers that protrude far in front of the head and are used to grip their prey; the pincers are hollow and, after injecting venom, are used to suck out the contents. After 2-3 weeks, the larvae pupate for about 5 days.

The adults are bright green to green-brown, 15-20 mm long, with two pairs of wings that are about the same size, clear with characteristic networks of veins and cross veins; the wings are held tent-like over the body when at rest and reach beyond the end of the body. The golden eyes are large for the size of the head, and the antennae of green lacewings are characteristically long. Lacewings release a strong smelling chemical when disturbed, earning them the name "stinkflies".

Impact

Green lacewing larvae prey mostly on aphids, but also attack scale insects, mealybugs, leafhoppers, thrips, psyllids, whiteflies, caterpillars, moth eggs, many other small insects as well as mites. The larvae are fast moving and voracious feeders; they can eat up to 200 aphids a week. Adults of some species also feed on insects and mites, but others feed only on pollen, nectar and aphid honeydew.

There are companies supplying eggs of green lacewings for the control of pests, mostly aphids and mites (see under Management as Biocontrol Agents).

Detection & Inspection

Look for adult green to greenish brown slender insects with long delicate wings with cross veins. Look for long antennae and distinctive golden eyes. Look for larvae which are like tiny alligators, with slender bodies, stiff hairs along their sides, and sickle-shaped mouthparts protruding from the head.

Management as Biocontrol Agents

Lacewings can be attracted by planting sunflowers or dill, or by allowing weeds such as dandelions to thrive near to crops.

In many countries, however, green lacewings are reared as biocontrol agents, and released on crops rather than waiting for them to come naturally. They are used against aphids and mites, in particular. Most often they are sold as eggs.

The number of eggs released varies with the type of crop, the pest to be controlled and the number of pests present. The following is a guide only (suppliers' recommendations should be followed): (i) protected crops - 1000 eggs per 100 m^2; (ii) field crops - 5000 eggs/ha. Preferably, two applications are made 10-14 days apart, in both situations.

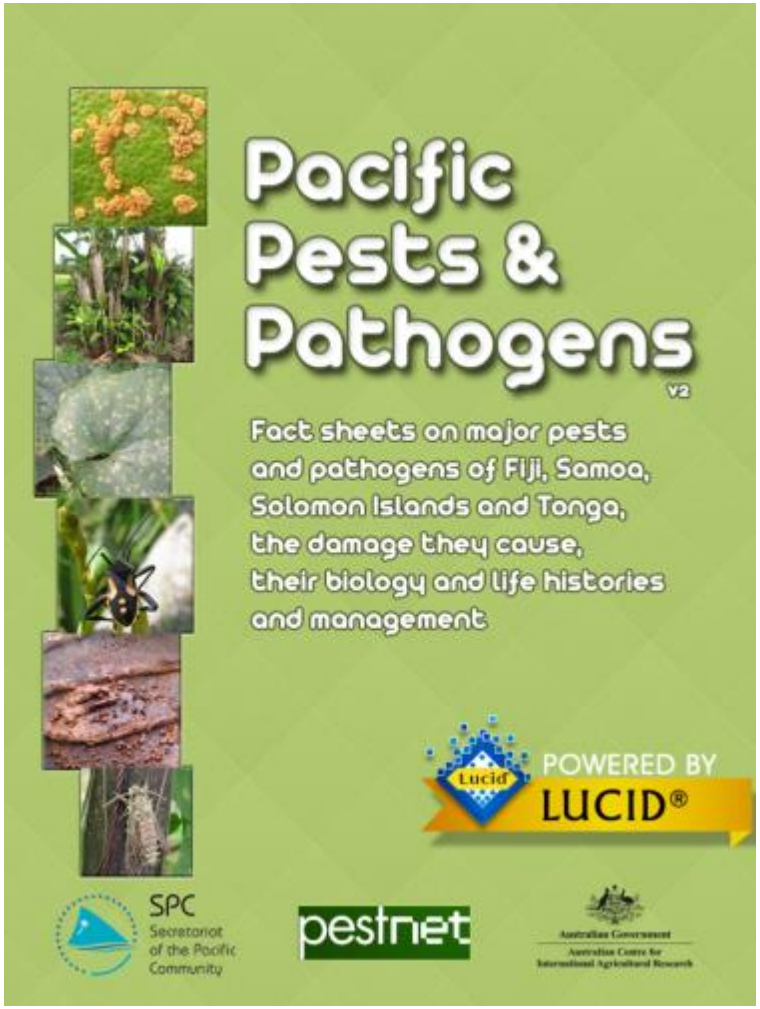
Species of Chrysoperla and Mallada, are most often used in biocontrol programs, and the eggs of these can be purchased in many countries. In the USA, Chrysoperla rufilabris and Chrysoperla carnea are the most common species sold. Consignments of eggs are packed with rice hulls, and sprinkled over pest infested plants. The overall performance is said to be variable, and research into improving the performance of lacewings in IPM programs continues.

AUTHOR Grahame Jackson
Information from Chrysopia. Wikipedia. (**https://en.wikipedia.org/wiki/Chrysopidae**); Neuroptera: lacewing and antlions. CSIRO. (**http://www.ento.csiro.au/education/insects/neuroptera.html**). Photos 1,3&4 Whitney Cranshaw, Bugwood.org; Photo 2 David Cappaert, Michigan State University, Bugwood.org.

Produced with support from the Australian Centre for International Agricultural Research under project PC/2010/090: Strengthening integrated crop management research in the Pacific Islands in support of sustainable intensification of high-value crop production, implemented by the University of Queensland and the Secretariat of the Pacific Community.

Link to these fact sheets online:

http://www.pestnet.org/fact_sheets



Using the App

Pacific Pests & Pathogens

Using this App Done

Pacific Pests and Pathogens

When crop pests and diseases occur, farmers want immediate help and advice. They don't want to wait and in many cases they cannot wait. Unless they act quickly, the crop could be completely ruined.

This app gives extension staff and lead farmers all the information they need to treat the crop instantly. If there is no way of saving a crop, the steps should help to prevent the problem occurring in the future.

To use this App

Either select 'Browse Fact Sheets' to view a list of available fact sheets, or select 'Identify Pests or Diseases' if you need to identify a pest or disease.

Browsing Fact Sheets

A list of available fact sheets will be displayed. Putting your finger on the title should open the fact sheet, and touching the thumbnail should open the gallery of images for that fact sheet.

Each fact sheet is divided into several sections: common and scientific names, distribution, hosts, damage, biology and life cycle and management. This Version 2 of the app contains 236 fact sheets; however, more fact sheets will be added over time.

Identifying Pests or Diseases

To identify a pest or disease:

- If you know what kind of pest you have open 'Find a fact sheet?'. Select one of the options, and swipe left to view the relevant fact sheets, otherwise:
- Choose the relevant crop, open 'Crops', and select one of the options, and swipe left.
- If you do not know what kind of pest you have, open 'What do you see?'. Select one of the options, and either swipe left to view the results or continue to 'Where is it?'.
- Open the 'Where is it?' question, select one of the options and swipe left to see the results that match your selections.
- When you have a list of possible matches, compare the thumbnail images of the fact sheets with your problem, or open the fact sheets as described above.

We would like to thank ACIAR, the Australian Centre for International Agricultural Research for providing support in the development of the app under a sub-regional (Fiji, Samoa, Solomon Islands and Tonga) IPM project (HORT/2010/090). We thank Identic Pty Ltd., (www.lucidcentral.org) for its development.

Plant Health Clinics

What are PHCs?

Countries realise the need to grow more food locally so as to reclaim food and nutrition security. However, intensification of production brings its own problems. For one thing, pests and diseases increase, and this puts pressure on agricultural extension services which are often not well equipped to deal with the challenges.

In response, Governments around the world are looking for ways whereby farmers can obtain pest and disease diagnoses and information on their management. Plant health clinics (PHCs) are seen as a possible solution, bringing accurate, up-to-date knowledge to farmers, enabling them to care for their crops more effectively.

PHCs advise farmers on pests and diseases, soil and other abiotic problems, in a similar way that health centres advise and treat humans.

Consultations take place in public places, mostly at markets, but also at trade and agricultural fairs. Farmers bring plants with problems caused by pests and diseases, or by nutritional problems, for "plant doctors" to diagnose and to prescribe safe, affordable and locally available solutions. The consultations are documented. Farmers' names and addresses are recorded, the problem described, diagnoses given and management options suggested and, importantly, a copy of the prescription form given to the farmers.

The plant doctors are from government agencies or non-government organisations, universities, colleges and even retail stores. The clinics are backstopped by specialists in the national plant protection agencies, and they in turn by international institutions, such as the Secretariat of the Pacific Community, PestNet and CABI Plantwise. These organisations provide backstopping in case identification and more information is required.

Pilot PHCs in the Pacific

In the last decade, PHCs have been established in South and Central America, throughout Asia, and across Africa. Under the ACIAR ICM/IPM project it was decided to hold them in Solomon Islands as a pilot for Pacific islands.

In May 2012, CABI visited Solomon Islands bringing together the Ministry of Agriculture and Livestock and the Kastom Gaden Association, at a workshop on the organisation and management of PHCs. Fact sheets were written and staff trained in using them. Thereafter, and for the next 16 months, more than 20 clinics were held on Guadalcanal and Malaita. In September 2013, Jeff Bentley, a pioneer of PHCs, carried out an evaluation. He considered the pilot PHCs were a success, and made recommendations for Solomon Islands and for other Pacific island countries.

His recommendations for extending the PHCs were as follows:

1. Run the PHCs through the extension service
2. Run a pilot for 1-2 years
3. Key activities of the pilot should be:
    - Training of extension staff
    - PHC duties to be included in extension staff TORs (ie their duty statements)
    - Write fact sheets on local pests and diseases
    - Sect a country coordinator – a champion with enthusiasm and commitment to PHCs
4. Make PHCs part of a plant health system: research, extension, dealers, farmers
5. Information from PHCs should be shared widely via radio, TV and extension programs

Remember, PHCs are meant to be "a regular and permanent service owned by the partners who operate them, unlike a project that has a definite end point".

SOLOMON ISLANDS

North Malaita

TAKWA PLANT CLINICS

Kastom Gaden Association | 20 & 21 August 2012







This plant clinic was held at Takwa village, north Malaita and organized by the Baetolau Farmers Network and Kastom Gaden Association. Two clinics were held: the first on 20 August at which 37 farmers attended, and the second on the 21 August with 26 farmers. Some came from several kilometres. All farmers brought samples, some brought many.

Problems were: taro alomae/bobone, taro leaf blight and mitimiti disease; sweetpotato scab; sliperi kabis shoot borer; yam nematode; banana scab, and root rots of edu and kongkong taro. Cassava with Amblypelta was a serious problem (lower right). The plant doctors were: Roselkyn, Joyce-Mary, Osanti, Rita, Verlyn, Thecla, Olga and Pita.

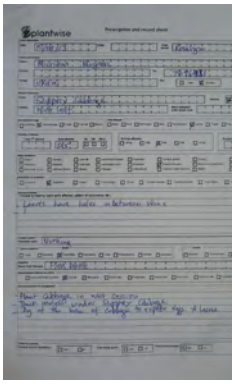
Prepared and reported by KGA. For more information contact Roselyn Kabu (roselynk@kastomgaden.org). Photos by GVHJ. *Plant clinics are held as part of a sub-regional IPM project, funded by ACIAR.*

SOLOMON ISLANDS

North Malaita

TAKWA PLANT CLINIC

KGA / MAL| 10 September 2013



This plant clinic was held at Takwa Market, and organized by the Bartolau Farmers' Network, KGA and MAL. The clinic is located about 80 km north of Auki at the end of Malaita. Many farmers participated at the clinic although only five brought samples. Some of the key problems presented were associated with taro with alomae and bobone, and sliperi kabis with Earias shoot borer and Nisotra flea beetle. Johnson demonstrated the control of Alomar and answered many farmers' questions.

The plant doctors were Osanti Luda, Johnson Ladota, Roselyn Kabu, Verlyn Lina, Freda Mudu, Olga Chapangi, and Pita Tikai.

Prepared and reported by Pita Tikai. ICM project (PC/2012/090). For more information contact Roselyn Kabu, KGA (roselynk@kastomgaden.org), or Freda Mudu, MAL (fredah.mudu@gmail.com). *Photos* by Jeff Bentley. *Plant clinics are held as part of a sub-regional IPM project, funded by ACIAR, Australian Centre for International Agricultural Research, Canberra.*