WHAT'S NEW IN

Biological Control of Weeds?

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Banana passionfruit fruit
Trevor James

What's Inside?

Landcare Research
Manaaki Whenua

Patience Required for Japanese Honeysuckle

The Japanese honeysuckle (*Lonicera japonica*) project has been busy in recent months with no less than four insects under investigation in containment at Lincoln as potential biocontrol agents. In June 2010 Quentin Paynter visited Japan and collected colonies of a white admiral butterfly (*Limenitis glorifica*), an as yet unnamed leaf-tying moth, a long-horn beetle *(Oberea shirahati*), and a sawfly (*Zaraea lewisii*).

The white admirals have proven impossible to get to mate in captivity. "With a previous shipment we tried hand-pairing, where we stunned the males with potassium cyanide, which will often induce them to mate out of desperation, but were unsuccessful and the colony died out," said Quentin. So we got in contact with a retired American professor, Austin "Bob" Platt (University of Maryland), who has successfully hand-paired a closely related species, *Limenitis camilla*, in the past. Bob agreed to come to New Zealand and see if he could help us next time we got in a shipment. We also hoped that the glass-roofed rooms with natural light in our new containment facility would help the admirals feel at home and mate naturally. However, it was not to be. Professor Platt, known as the "master mater", was unable to encourage the butterflies to breed despite trying a range of hand-pairing techniques. We even tried a "cold male/ hot female" technique where we let the males pass out in the freezer instead of the stunning jar, but still had no luck. No matter what we did the male butterflies were completely disinterested in mating. The females, on the other hand, were happy to lay eggs on potted plants in containment but, because they had not been mated, the eggs were infertile.

"Obviously the males still need something we can't provide indoors so our only remaining option for host testing this species now is to do the work in Japan using field-collected larvae," said Quentin. Our colleague Shaun Forgie has figured out how to easily tell *L. glorifica* and *L. camilla* caterpillars apart using molecular techniques, so we can be sure we are testing the right species. The plan is to collect eggs from sites known to be predominantly *L. glorifica* and conduct host testing with the larvae that hatch. Larvae that starve to death will be preserved in alcohol and sent to New Zealand for DNA identification. Those that are reared through to adult will be easily identified as *L. glorifica* or *L. camilla*. Quentin is planning to undertake this work next June.

The first sawfly colony we imported was thought to have died out as it looked like the larvae had failed to pupate successfully. Since then we have learnt that the species is very long lived, and the larvae may remain dormant within cocoons for up to 2 years before they pupate. We will just have to wait and see what happens with the small number of pupae we have. We will likely need to import another shipment. So it may be some time yet before we know if we are able to successfully work with this species.

Little is also known about the stem-boring longhorn beetle or the leaf-tying moth so our first priority is to learn about their life cycles and how to rear them, and undertake host testing when we can. Some preliminary work with the leaf-tying moth indicates that it is specific to the genus *Lonicera*. The power failure in the Invertebrate Containment Facility (see facing page) meant we lost some of the longhorn beetle colony. We think there are still a small number of eggs and larvae still alive, but we can't risk opening the stems to take a good look. In any case we will need to import further shipments of both insects next year in order to have enough to be able to complete host testing, which by its very nature usually kills off much of our colonies by subjecting them to unsuitable hosts.

A tip-feeding moth (*Bhadorcosma lonicerae*) that we have been interested in has dropped down the priority list. It has only one generation a year, so, even if it has a big impact early on, plants have a chance to regrow later in the year when it is dormant. It may work well in combination with other agents though, so we have not written it off completely. However, we have now dropped the moth with the hairy caterpillars (*Apha aequalis*). Field records have confirmed

Professor Platt and Quentin with white admiral butterflies in containment.

our tests that suggested its host-range is too wide for it to be suitable to use in New Zealand. But with at least four good prospects up our sleeve, hopefully an effective line-up to control Japanese honeysuckle will still be possible in due course.

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This project is funded by the National Biocontrol Collective.

Nature Tests Invertebrate Containment Facility

Our brand new Invertebrate Containment Facility at Lincoln got a thorough testing with the 7.1 magnitude earthquake and associated aftershocks that struck Canterbury in early September. Unlike the Lincoln pub, which is sadly no more, the containment building itself was not compromised and there was no structural damage inside. Although the earthquake caused power outages to much of the greater Christchurch area, including Lincoln, the new generator kicked in, and everything seemed fine when the site was checked a few hours after the quake. Normal power was restored later that day. However, more aftershocks and strong winds the day after caused another power outage, which stopped the computer programme that runs the building. This failure resulted in the cooling system shutting down. When the generator again kicked in the lights came back on but the cooling system did not. "In two hours several rooms in the containment facility heated up to 50°C and one almost got to 60°C!" said Hugh Gourlay, Facility Manager. As you can imagine, this caused some carnage.

The programmes hardest hit by the loss of insects are banana passionfruit (*Passiflora* spp.) and tradescantia (*Tradescantia flumensis*). We have a few survivors of all the species most seriously impacted but it remains to be seen whether there are enough healthy individuals to maintain the populations. The colony of the banana passionfruit leaf, flower and fruit-feeding moth (*Pyrausta perelegans*), for example, has dropped from about 1000 eggs/larvae to only 18 larvae and all pupae/adults have been lost. Likewise the number of banana passionfruit stem-boring moth (*Odonna passiflorae*) larvae has dropped by 80%, and many of them don't look too healthy (see *Promising Moth for Banana Passionfruit* this issue). While we have permission to import more moths from Colombia, we are unsure when this can be arranged.

All of the hard work line-rearing the tradescantia leaf beetle (*Neolema ogloblini*) to eliminate a gut parasite has been seriously impacted with 13 of the 17 rearing lines lost. "We've very disappointed, as these beetles represented significant effort and value in both their genetic diversity and disease-free status," said Lindsay Smith. The other two beetles (*N. abbreviata* and *Lema basicostata*) also lost significant numbers though the impact has not been as great as for the leaf beetle. Releases of the leaf beetle will be delayed due to the population crash. We may need to import new individuals of all species to prevent the possibility of creating a genetic bottleneck in our populations.

Lynley's office after the earthquake.

Another programme affected is Japanese honeysuckle (*Lonicera japonica*) biocontrol (see facing page). Our newly imported population of stem-boring longhorn beetles (*Oberea shirahati*) has dropped to only a small number of eggs, which we think are still alive. However, a planned trip to Japan next year should replenish our colony. Luckily the woolly nightshade lace bugs (*Gargaphia decoris*) were not affected, and neither were populations of broom (*Cytisus scoparius*) and thistle (*Cirsium* spp. and *Carduus* spp.) agents, so the mass-rearing programme for these species this season is still on track.

While these setbacks have been disappointing, the fact that no human lives were lost in the earthquake is still a miracle. Our staff at Lincoln are very grateful for everyone's support and the messages of sympathy and encouragement they have received over the trying period following the earthquake and associated aftershocks (which are continuing and now number over 2000!).

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Can Genetic Diversity Predict Weeds?

When it comes to preventing future weeds in New Zealand we are quite cautious and want to ensure no new "nasties" get into the country, but we already have more than enough potential "nasties" here with about 2500 naturalised plants already occurring in New Zealand. About 700 of these are classified as weeds or emerging weeds. For many species there is a "lag period" between when an introduced plant becomes established (naturalised) and when it turns into a serious threat (weed). This can be tens to hundreds of years. If we want to prevent future invasive weeds it is important to understand the processes involved during this transition. Once we understand what is happening we can develop strategies for managing invasions and preventing new ones. Despite the significance of the naturalised-to-weed transition period there is a poor understanding of the ecological and evolutionary processes involved. Recent work by Gary Houliston and Peter Heenan has investigated the genetic diversity of two introduced Australian plants to try to find some clues.

It is assumed that the population of an introduced plant, especially one cultivated for sale (where there would be selection for particular desirable characteristics), would contain substantially less genetic variation than the population in its native range. Genetic diversity is an indication of a population's ability to become established in a new environment. "The higher the genetic diversity, the greater the likelihood that a population contains a genotype (genetic form) suited to the introduced environment, thus enabling establishment," explained Gary.

Coastal banksia (*Banksia integrifolia*) is an emerging weed in New Zealand and alpine wattle (*Acacia pravissima*) is starting to cause concern. Both species are potentially serious threats to New Zealand biodiversity yet lack of evidence to support a weedy classification means that they are not regarded uniformly across the country. In the case of coastal banksia, one North Island regional council enforces restrictions on its propagation while a neighbouring authority is actively planting it in reserves. Gary compared the genetic variation in native (Australia), introduced (naturalised populations in New Zealand) and cultivated (plants in nurseries in New Zealand) populations of the two species. The diversity of genetic material in each population was determined by examining microsatellite markers in DNA.

"Our initial results show a surprising amount of genetic variation in the naturalised populations of both species in New Zealand," said Gary. Both coastal banksia and alpine wattle, but particularly the former, proved to be more genetically diverse than was expected. Cultivated populations of the two species were also surprisingly diverse. Both species are long lived and have been in New Zealand for a relatively short period so this diversity is unlikely to be due to evolutionary changes since their introduction. What seems more likely is that the high diversity is a result of multiple introductions.

Applications to introduce new organisms, including plants, into New Zealand are based on species. Variation below species level, which relates to the genetic diversity of a population, is currently too fine a detail for management decisions. However, importations of a particular plant species will not all contain the same genetic diversity. If individuals are sourced from a variety of populations within the native range the introduced population will contain a greater genetic diversity than if individuals are sourced from a limited number of sites. In addition, new genetic mixtures may inadvertently be created by bringing together individuals that grow in different parts

Coastal banksia growing in its native range.

of the native range and do not naturally come into contact. The creation of new genetic combinations can also be made once the plant is introduced by people cross-breeding plants in cultivation. These novel genetic mixtures, which do not occur in nature, may increase the likelihood of the introduced population establishing in the new environment, should it get the chance. Such novel genetic mixtures may also be more difficult to control biologically if they become weedy, as natural enemies may not be well adapted to them.

Gary also compared the health of coastal banksia in Australia and New Zealand. The plant has a wide distribution in Australia but in some parts of its native range is so hard hit by natural enemies – herbivores and diseases – that it is hard to find a healthy plant. By contrast in New Zealand, where plants have had to undergo phytosanitary inspections prior to arriving in the country and have escaped from their natural enemies, it is doing extremely well.

The preliminary findings of this study suggest that the genetic diversity in an introduced plant population does influence the likelihood of it becoming a problem, should it escape into the wild. It seems that naturalised plant populations with high genetic diversity are likely to have a shorter "lag phase" before becoming weedy than less genetically diverse populations.

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This project is funded by Landcare Research Capability Fund.

Plant Identification Workshop

If there is sufficient interest we will hold a one-day plant identification workshop at Lincoln in March 2011. Many people have recently attended workshops organised by MAF on how to identify plants on the National Pest Plant Accord list. The Landcare Research workshop has a broader focus and will cover how to identify a much wider range of plants, using traditional floras and the web-based interactive keys now available (grasses, pines, coprosmas, common native plants, and NPPA plants). In addition, new keys not yet online will be demonstrated (native and introduced genera in New Zealand, native orchids, and a key to weed species). There will be an emphasis on how to correctly interpret characters when using keys. The day will be tailored to the needs of the participants and they can bring their own material to work on if they choose. The cost will be $500 per participant. For further information or to register your interest in attending, please email Murray Dawson (dawsonm@landcareresearch.co.nz).

Changes to Pages

If you are making an effort to keep your copy of *The Biological Control of Weeds Book – Te Whakapau Taru* up to date you need to go online and download some new and revised pages. Go to www.landcareresearch.co.nz/research/biocons/weeds/ and print out the following:

- Index
- Contacts
- Blackberry Rust
- Boneseed Leafroller
- Broom Gall Mite
- Broom Leaf Beetle
- Broom Psyllid
- Broom Shoot Moth
- Californian Thistle Stem Miner
- Californian Thistle Stem Miner Recovery Form (new)
- Green Thistle Beetle
- Tradescantia Leaf Beetle
- Woolly Nightshade Lace Bug (new)
- Release Sheet

Promising Moth for Banana Passionfruit

The leaf, flower and fruit-feeding moth (*Pyrausta perelegans*) is looking very promising as a potential biocontrol agent for banana passionfruit (*Passiflora* spp.) but further investigation is needed to confirm its suitability for New Zealand. Initial host testing showed that the caterpillars could feed on our native passionfruit, kōhia (*Passiflora tetrandra*). However, these tests were conducted in small cages and sometimes moths show artificially broad host-ranges in captivity, so we need to determine whether this non-target attack is real or a false-positive result. The best way to do this is by repeating the testing in field trials under natural conditions. There are two possible locations for setting up such a field trial: Colombia, which is in the moth's native range, and Hawai'i, where the moth has been released as a biocontrol agent. However, this has proved to be easier said than done, as providing plants for the trials from New Zealand has been challenging. Two shipments sent to Hawai'i perished during the year they were required to remain in containment, and it appears that our native passionfruit finds it too hot there. The first shipment sent to Colombia also died, but a second, in August 2008, arrived safely and has been successfully planted out.

The field trial in Colombia has been set up in an area where the moth and a second potential agent, a stem-boring moth (*Odonna passiflorae*), naturally occur. Plants of the weedy banana passionfruit species (*Passiflora tripartita* var. *mollisima* and *P. tarminiana*) have also been planted in the area.

Damage caused by the stem-boring moth. Insert: Larva.

Hugh Gourlay visited Colombia at the end of July to see how the trial was going. "The native passionfruit plants are still quite small at this stage and we will need to wait for them to grow larger before we can assess if they really are at risk of attack by the two moths," said Hugh.

While in Colombia Hugh was able to collect a colony of the leaf, flower and fruit-feeding moth to bring back to New Zealand for further study. This meant that Hugh has been able to repeat some of the host-specificity testing in larger cages. Results show that when given a choice the moths laid very few eggs on either the native passionfruit or black passionfruit (*P. edulis*), instead laying lots on weedy banana passionfruit, and, interestingly, on the cages. "In no-choice tests the moths also preferred to lay on the cages than on native passionfruit," said Hugh. The results could be due to the moths being better able to discriminate between passionfruit plants in the larger cages, or having a slightly different host range as they were collected from a different location. Whatever the reason, we are quite hopeful now that the field test will confirm the moth is suitable to release in New Zealand.

Hugh also collected a colony of the stem-boring moth to bring back to New Zealand. The biology and ecology of this moth are not very well known at all. Victoria Barney, our Colombian colleague, took Hugh to a site where the caterpillars are killing *P. tarminiana* plants, but she has rarely seen pupae and has never seen the adult moths in the wild. We know that the caterpillars are very long lived and it may take up to a year for newly hatched caterpillars to become pupae. "I had hoped to start host testing right away but I need to work out how to rear this insect first," said Hugh.

Unfortunately our populations of both moths were significantly reduced by the power outage in the Invertebrate Containment Facility in early September (see *Nature Tests Invertebrate Containment Facility* this issue). So, what with needing to import further shipments of both moths, and waiting on the results of the field trial in Colombia, it seems that the first biocontrol agent for banana passionfruit is still a little way off.

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This project is funded by the National Biocontrol Collective.

Summer Activities

Boneseed leaf roller caterpillar.

Summer is a busy time for many of our biocontrol agents as rising temperatures and longer days trigger active stages in their life cycles. Some things you might like to fit in during these warm months are:

Boneseed leafroller (*Tortrix* s.l. sp. "chrysanthemoides")

- Check release sites. Look at the stem tips for shelters made from curled leaves tied together with webbing, and sprinkles of black frass. Signs of caterpillar feeding are "windows" in the leaves where the green tissue has been eaten away and the leaf may be turning brown. We would be very interested to hear of any instances of severe damage to the foliage. You may encounter a native leafroller species (*Ctenopseustis* sp.) that is a similar colour to the boneseed leafroller, but it does not have the rows of white spots.
- If you find good numbers of caterpillars, you can begin harvesting and shifting them around. Cut off infested boneseed tips and wedge them into plants at the new site. Aim to move at least 500 caterpillars. Do not choose a site where Argentine ants are present as the leafrollers are unlikely to survive.

Broom leaf beetle (*Gonioctena olivacea*)

- Check release sites. If you are lucky you may see larvae feeding on the leaves and shoot tips. Adult beetles are small (2–5 mm) and, while colouration can be variable, females tend to be orangey-brown and males have an orangey-red tinge. If you can't find adults or larvae, it is worth gently beating some foliage over a white sheet.
- We would not expect you to find enough beetles to begin harvesting and shifting them around yet.

Broom seed beetle (*Bruchidius villosus*)

- Harvest and redistribute beetles while they are still inside mature brown pods. Avoid green pods as the beetles inside will not be completely developed. Cut infested branches and wedge them into bushes at the new site. A period of hot weather can cause pods to ripen rapidly so don't delay once the first ones have started to burst.

Gorse soft shoot moth (*Agonopterix ulicetella*)

- Check release sites, but get onto it quickly. The caterpillars have grown quite large by late November or early December and will pupate soon after. They are dark brown or greyish-green and are found inside webbed or deformed growing tips. We would be very interested to hear of any outbreaks of caterpillars found in new locations – particularly in the North Island and lower South Island.
- Caterpillars can be redistributed by harvesting infested branches or even whole bushes.

Green thistle beetle (*Cassida rubiginosa*)

- Check release sites for feeding damage, which looks like windows eaten into the leaves. You are more likely to see larvae carrying dark distinctive bundles on their tail spines than adults, due to their cryptic colouring.
- It may be possible to begin harvesting and redistribution from some of the oldest release sites if you can find the beetles in good numbers. We expect that the best way to collect these beetles will be using a garden-leaf vacuum machine. Aim to shift at least 50 adults in the spring. Be careful to separate them from other material collected during the vacuuming process, which may include pasture pests.

Gorse thrips (*Sericothrips staphylinus*)

- Check release sites, in particular areas of new growth. Remember to do so when gorse isn't flowering so you won't be confused with flower thrips (*Thrips obscuratus*). If you can't see any thrips by eye, use a hand lens or try gently beating some foliage over a white sheet.
- If you find good numbers, thrips can be redistributed by harvesting infested branches and wedging them in bushes at the new site.

Hieracium gall midge (*Macrolabis pilosellae*)

- Check release sites. Look for plants with swollen and deformed leaves caused by larval feeding. Do not try to redistribute this agent over summer as whole plants need to be moved and it is crucial that they do not dry out.

Send any reports of interesting, new or unusual sightings to Lynley Hayes (hayesl@landcareresearch.co.nz, Ph 03 321 9694). Don't forget that you can access release and monitoring forms for most species at www.landcareresearch.co.nz/research/biocons/weeds/book/ under Release and Monitoring Forms.

Potential for Pampas Biocontrol

Native flax notcher caterpillar on pampas.

In the past it was believed that grasses would be too difficult to consider as targets for biocontrol. Our Chilean needle grass (*Nassella neesiana*) project has disproved that, and we are now embarking on a second grass project, against pampas (*Cortaderia selloana* and *C. jubata*). Pampas is a seriously invasive weed in New Zealand. Once promoted as an edible shelter belt and soil stabiliser, the large tussock-forming grasses cause problems for native species and agriculture, particularly forestry. Heavy pampas infestations in *Pinus radiata* forestry can reduce tree growth by up to 60%. Pampas is good at invading bare ground and is a significant threat to areas of high conservation value such as coastal cliffs, dunes, wetland and turfland. In some of these areas it is displacing native toetoe (*Cortaderia* spp.). Pampas also provides cover for predators and vermin and creates a significant fire risk due to the build-up of dry leaves.

Pampas produces a huge number of seeds. Each flowerhead can produce up to 100,000 seeds. These seeds are small, light and have long fine hairs which help them disperse on the wind for distances up to 25 km. Seed germination is also fairly rapid, with no dormancy. Both species grow quickly, up to 4 m in height, and can live for 10–15 years.

Pampas is difficult to control. Fire and mechanical control have been used in the past but are dangerous, expensive and damage non-target species. Herbicide is most commonly used now but the risk of damage to desirable plants is high and any bare ground created is rapidly recolonised by more pampas. In addition, Forest Stewardship Council certification requires the forestry industry to reduce its reliance on chemical control for weeds.

A survey of the natural enemies attacking pampas in New Zealand has recently been completed. A wide range of native and introduced invertebrates was found on pampas but the overall damage is minimal (<1%) and no specialised pampas-feeding species were found. The most obvious damage, which was minor, was caused by the native flax notcher moth (*Tmetolophota steropastis*).

"Introduced biocontrol agents are unlikely to meet any significant competition as none of the niches on pampas are well utilised here, and some (e.g. leaf-mining) not at all," said Chris Winks, who led the insect herbivore survey. There are generalist predators and some parasitoids here that could inhibit the effectiveness of some potential invertebrate biocontrol agents, but this can be taken into account when shortlisting any potential agents.

A huge variety of fungal pathogens were collected from pampas but again the damage was minimal. Most can be discounted because they are not specific enough. "Further research is needed to look into the potential for mycoherbicide development for some species found," said Stan Bellgard. The potential that a couple of species found could influence the impact of biocontrol agents will be investigated as part of a wider project on endophytes.

The next step is to conduct surveys to find out what the natural enemies of pampas are in its native range, and funds need to be sourced for this work. Last September a multi-agency group, the National Pampas Biocontrol Initiative, formed to raise funds for this work. An application to the MAF Sustainable Farming Fund by the group earlier this year was not successful, but was viewed favourably and will be resubmitted this year. In the meantime the limited funds available for pampas are being used for DNA studies to try and pinpoint where in South America New Zealand pampas came from, and a very preliminary survey in Argentina.

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