What's New In Biological Control Of Weeds?

What's Inside:

Issue 26 November 2003

ISSN 1173-6356

Manaaki Whenua
Landcare Research

Piecing Together the Past

Helen Harman recently successfully defended her doctoral thesis on the population genetics of the self-introduced broom twig miner (*Leucoptera spartifoliella*). In contrast to deliberately released biocontrol agents, nothing was known about the individuals that originally arrived in New Zealand so Helen set out to unravel some of the mysteries behind this foliage-feeding insect.

The twig miner was first collected near Rotorua about 50 years ago. Helen studied records of how quickly this insect was subsequently found in other areas and, using a computer model that predicts dispersal, was able to draw several conclusions. The rate at which the twig miner colonised New Zealand suggests that it was either here for some time before anyone noticed or it was helped to get around in some way. "The latter theory seems quite plausible since it is likely that the twig miner arrived here on cuttings of ornamental broom plants. These were destined for plant nurseries and keen gardeners could easily have spread them far and wide," explained Helen.

Using specialised molecular techniques to study the twig miner's DNA, Helen was able to determine that it probably established here as the result of a single introduction of a few individuals. Helen reports, "Even though there was some loss of genetic variability in New Zealand populations (compared with populations from its native range in western Europe), the overall variability was still high. This has been sufficient to allow the twig miners to thrive under a variety of conditions through the range of broom in

Our newest doctor, Helen Harman.

New Zealand." Heavy damage has now been seen in many places, especially in the South Island, and studies have shown that when present in good numbers the insect can stunt broom's growth quite dramatically.

Helen found that the populations she studied from the broom twig miner's native range were genetically quite similar to each other with most of the variation found within populations. This indicates a high rate of gene flow, probably due to the mobility of the adults. "If we are sourcing biocontrol agents overseas and know beforehand that the populations have low genetic differentiation, then we probably don't need to be as fussy about where we collect them from since much of the genetic variation is likely to be present in a single or a few populations," concluded Helen.

The group's newest doctor will be putting her new diagnostic skills to good use in a range of projects.

Hot Gossip

An extremely successful workshop was held in Christchurch immediately preceding the New Zealand Plant Protection Society's annual conference in August to ponder **wilding conifer control** and, in particular, whether biocontrol might ever be a solution to this problem in New Zealand. This was the first time that all affected stakeholders had come together for a frank and open discussion about the problem. Regional councils provided the funding which allowed this workshop to happen. Additional sponsorship from Landcare Research, Forest Research, the Department of Conservation, the Ministry of Agriculture & Forestry, and the Commonwealth Science Council made it possible for us to fly in some overseas experts (John Hoffmann, University of Cape Town, and Andrew Storer, Michigan Technical University) and to allow a substantial proceedings to be produced. Some of the main outcomes were:

- We have good manual control techniques but not necessarily enough funding or skilled personel to get on top of the problem while it is still possible.
- There is still a lot we don't know about the potential safety and usefulness of biocontrol agents. The major stumbling block could be that if the serious disease pine pitch canker (*Fusarium subglutinans* f. sp. *pini*) was ever accidentally introduced here then biocontrol agents might spread it around. However, the feasibility of using biocontrol agents warrants more research.
- The use of fire, although also controversial, warrants more research.
- People want to work together to find a solution to this problem. Volunteers were sought to form a committee that will progress this further. It is hoped that the committee will meet for the first time in December.

Richard Hill (Richard Hill and Associates) made a great job of organising this workshop for us and he is currently working on the proceedings, which he hopes will be available before the end of the year. If you missed the workshop and would like to purchase a copy of the proceedings please get in touch with Lynley Hayes (Ph 03 325 6701 ext 3808 hayesl@landcareresearch.co.nz).

Sadly **Tom Jessep** lost his battle with cancer in July. He retired from Landcare Research in 1997 after a 40-year crusade to free New Zealand of unwanted pests. Tom was perhaps best known for his efforts to control thistles and he was responsible for importing three agents to attack **nodding thistle** (*Carduus nutans*) – all have established well and are now a familiar sight on nodders. Tom also laid some of the groundwork for our successful technology transfer programme by making some of the first linkages with noxious plants officers and getting them enthused about biocontrol. Thanks to Tom nodding thistle is no longer the terrible purple peril that it used to be, with the plant now well controlled in many areas. Next time you see a receptacle weevil (*Rhinocyllus conicus*), gall fly (*Urophora stylata*) or crown weevil (*Trichosirocalus mortdelo*) remember to say a little thank you to Tom.

Tom, his wife Nancy, and Phil Crotty (Environment Canterbury) collecting nodding thistle crown weevils shortly before Tom's retirement.

Welcome Quent

We are delighted to welcome a new member to our team. Quentin Paynter is our new "Insect Ecologist/ Biocontrol Scientist" and will be based at our Auckland office (email: paynterq@landcareresearch.co.nz or Ph 09 815 4200 ext 7086). Quentin will be working on several projects, including looking at non-target impacts of biocontrol agents, impacts of biocontrol agents on old man's beard (*Clematis vitalba*), an economic evaluation of broom (*Cytisus scoparius*) control, and improving biocontrol of alligator weed (*Alternanthera philoxeroides*).

Quentin has spent the past 5 years working for CSIRO in Darwin, Australia, looking at the integrated management of a woody shrub, mimosa (*Mimosa pigra)*. "That work involved evaluating the impact of biocontrol on mimosa and designing control options that would integrate biocontrol with other management methods," explained Quentin. "We predicted that biocontrol would control mimosa on its own but would take a long time to do so. However, we found that, when used together, biocontrol actually enhanced the impact of other control methods. In fact, some biocontrol agents did better and increased in number when used in combination with other methods, such as herbicide and bulldozing," revealed Quentin.

Prior to his work in Australia, Quentin worked for CABI based in Montpellier, France. At Montpellier Quentin was responsible for sourcing biocontrol agents for broom and sending them to New Zealand, Australia, and the United States. He also conducted ecological studies to determine why broom is a weed and the potential impact different biocontrol agents might have on it. "We investigated the differences in how broom grows in its native range versus how it grows where it's introduced. From this, we could identify the characteristics that allow it to become a weed," explained Quentin. The characteristics could then be put in a modelling programme and the consequences of manipulating each on the success of broom examined. "We found that the best way of controlling broom with biocontrol was to use agents that reduce the life span of the plant, and damage it so that seedlings are less likely to establish underneath older plants. These two characteristics appear to be the most important areas to target," said Quentin.

Quentin's move to New Zealand will bring back some memories of his time in France as he has been "reunited" with his boss at Montpellier, Simon Fowler, and will be continuing work on broom.

Quent doesn't mind getting wet or muddy for a good cause!

A self-confessed "mad, keen bird watcher", Quentin has enjoyed viewing birds around the world. He is proud to include the rare African green broadbill and the shoebill ("rather like a big, grey, pterodactyl"), also from Africa, on his list of birds seen. "I try to not let bird watching interfere in work … too much," Quentin admits. He met his wife, Janine, at a workshop on Montpellier broom (*Teline monspessulana*), which was the subject of her PhD study at the time. They have an 8-month-old daughter Jennifer. We welcome the whole family and are sure that the biocontrol of weeds in New Zealand will benefit from Quentin's expertise.

Enlisting New Weed Warriors

Julia with pupils from Ouyen Primary School releasing bridal creeper leafhoppers.

During September, Julia Wilson-Davey spent 2 weeks in Australia meeting people who are involved in weed education and awareness-raising programmes. The Australians are a jump or two ahead of us when it comes to this kind of thing. The focus of Julia's trip was to learn all the secrets about how their most successful programmes operate and get some advice about how similar programmes could be developed here in New Zealand.

Julia spent a week in Melbourne hosted by the "Weed Warriors" team (Raelene Kwong, Kate McArthur, and Megan McCarthy), at the Department of Primary Industries (formerly the Keith Turnbull Research Institute). This programme teaches school children about weeds through rearing biological control agents in the classroom and releasing them onto local weeds. The practical nature of the programme and the responsibility of looking after live insects that have been reared for the specific purpose of controlling weeds help make the "Weed Warriors" programme appeal to both students and teachers alike. "One school has participated now for 3 years in a row. They have recently formed a buddy system with another school and the students from one school are teaching the programme to those at the other school," revealed Julia.

Julia accompanied Megan McCarthy, the Victorian Weed Warriors Co-ordinator, to visit four rural primary schools for the release of the bridal creeper leafhoppers (*Zygina* sp.) that they had reared. "It was a great opportunity to see 'Weed Warriors' in action in different schools. I particularly noticed how the teacher's level of enthusiasm affected that of the children. The teachers at one school were very enthusiastic and incorporated the insect rearing into other subjects, including maths and art. The students also made presentations to the junior classes, teaching them about bridal creeper (*Asparagus asparagoides*) and biological control," explained Julia.

In Western Australia, Julia met two CALM (Department of Conservation and Land Management) Bush Rangers Units. "Bush Rangers" is an extracurricular programme for 13 to 17 year olds that have an interest in conservation. Weeds are not the main focus of the programme, but weed control is an activity that they often get involved with. Julia visited the Bush Ranger Unit based at Rossmoyne Senior High School in Perth, with Bush Rangers Co-ordinator Bronwyn Humphreys. "Sydney golden wattle (*Acacia longifolia*) is an environmental weed that is growing in the school grounds. The Unit decided to take action against it and discovered that the Perth Zoo was looking for sources of food for their giraffes. They now regularly meet with a keeper and help him collect Sydney golden wattle foliage for the animals. It's a real win-win situation!" enthused Julia.

Several themes emerged during Julia's discussions with programme co-ordinators. "Working with schools and the community is rewarding but takes up a lot of time and energy! It's also wise to have clear goals, start small, and keep it simple," reveals Julia. Luckily we have been fortunate enough to secure a Royal Society teaching fellow, Richard Goldsbrough, to work jointly with Landcare Research and the Department of Conservation next year. So hopefully it won't be too long before we will be taking some similar weedy educational initiatives into classrooms here too! In the meantime schools can make a start on their own by dipping into Margaret Stanley's wonderful new addition to our website (see www.landcareresearch.co.nz/education/). This new educational resource provides a lot of background information about weeds and lots of great ideas for studying them in the classroom.

Julia would like to thank QE II Technicians' Study Awards for making this trip possible and all the people who hosted her trip in Australia.

Disagreements, Delays and Big Decisions

Problems can arise when a plant is considered a dreadful weed by some but a highly useful resource by others. Serious conflicts of interest can cause major delays to biocontrol programmes or even prevent them from getting underway at all. Recently Margaret Stanley has undertaken a postdoctoral study of the whole conflicts-of-interest conundrum, and she presented her findings at the XI International Symposium of Biological Control of Weeds in Canberra earlier this year. Potential conflicts are usually identified early on when the feasibility of a biocontrol programme is being evaluated and typically there is opposition from at least one industry group.

Economic protests

"Often conflicts associated with biocontrol of weeds come down to money," explained Margaret. When an industry (typically beekeepers, horticulturalists, farmers, or foresters) stands to lose money if a weed is controlled then not surprisingly they object (see table on pages 6–7 for examples worldwide). Sometimes one industry is pitted against another, e.g. beekeepers were opposed to biocontrol of nodding thistle (*Carduus nutans*) while farmers supported it. Sometimes there can be divisions within a single industry, for example, Paterson's curse (*Echium plantagineum*) was reviled by most farmers in Australia, except for graziers in drought-prone areas – who called the plant "Salvation Jane". These graziers banded together with beekeepers to oppose biocontrol, resulting in a hold-up of nearly a decade.

Perceptions and values change over time so economic conflicts can also arise further down the track, especially with the development of new industries. St John's wort (*Hypericum perforatum*) was one of the top four weeds in New Zealand at the turn of the century but is now gaining popularity in the natural pharmaceutical industry as an antidepressant and is even being grown as a crop in some regions. Potential crops that might be grown in future are considered when the feasibility of a biocontrol programme is being studied.

Industry of one type or another can be blamed for most of our environmental weeds. A recent example is kiwifruit (*Actinidia* spp.), which is now becoming a problem in the Bay of Plenty. "It's not surprising that many horticultural plants, which are selected for their fast growth rates and adaptability, become environmental weeds – the same traits that make them suitable for forestry or horticulture also make them potential invaders," warned Margaret.

Non-target worries

Trouble also arises when people suspect there is a possibility of biocontrol agents attacking beneficial non-target plants. A biocontrol programme for sweet briar (*Rosa rubiginosa*) was abandoned because of strong opposition from the rose-growing industry worried about collateral damage.

Serious delays to our biocontrol of broom (*Cytisus scoparius*) programme

Table 1. Summary of economic biocontrol conflicts of interest worldwide.

Weed and location	Possible adverse effects to:	Outcome
Acacia cyclops **(Rooikrans)** South Africa	Wood industry – timber, bark extracts, firewood. Stabilisation of dunes.	Biocontrol delayed. Seed feeders an acceptable alternative, and a weevil released in 1991.
Acacia mearnsii **(Black wattle)** South Africa	Wood industry – timber, bark extracts (tannins), firewood. Horticulture – seed and seedlings for forestry.	Biocontrol delayed. Seed feeders the only acceptable alternative. Researchers proved chemical protection of seed orchards possible. Weevil eventually released in 1994.
Acacia melanoxylon **(Blackwood)** South Africa	Wood industry – timber, bark extracts, firewood.	Biocontrol delayed. Seed feeders an acceptable alternative.
Acacia saligna **(Port Jackson willow)** South Africa	Wood industry – formal industry and poor communities who sell and use the wood. Farmers – shade, animal fodder, sand binder.	Biocontrol delayed. Gall-forming rust released 1987. Possibly should have released seed feeders instead, but economic benefits far outweigh potential losses.
Cannabis sativa **(Marijuana)** United Nations	Drug producers – immense monetary worth.	Agent found but not released because of international politics and violent retribution feared.
Carduus nutans **(Nodding thistle)** New Zealand	Apiarists – valuable nectar source.	Biocontrol briefly delayed then agents released. Nectar production more likely to be reduced by herbicide than biocontrol.
Centaurea solstitialis **(Yellow star thistle)** USA	Apiarists – flowers valuable source of nectar.	Biocontrol agent released. Committee recommended investigation of useful replacement plants for beekeepers.
Chondrilla juncea **(Skeleton weed)** Australia	Farmers – fatten lambs and feed stock in dry periods.	Biocontrol agent released. Small losses compared to economic benefits of controlling the weed.
Chromolaena odorata **(Triffid/Siam weed)** Africa	Farmers – considered a valuable fallow species for farmers who use shifting agriculture techniques.	Release of biocontrol agents still blocked in most of West Africa.
Cytisus scoparius **(Scotch/ English broom)** USA, New Zealand, Australia	Horticulture – ornamental plant. Apiarists – pollen. Farmers – fodder. Non-targets – e.g. tagasaste (*Chaemaecytisus palmensis*) affected by some agents.	Biological control agents released in all three countries. More detailed investigation of costs and benefits required before release of further agents in NZ. Impact assessments required before new agents are released in Australia.
Echium plantagineum **(Paterson's curse)** Australia	Apiarists – flowers produce large quantities of nectar and pollen. Farmers – potential source of fodder during drought.	Court proceedings led to an injunction on release (1980). Ban finally lifted in 1988 and agents released.
Eichhornia crassipes **(Water hyacinth)** India	Production – paper, mulch, alternative source of fuel (biogas), purify sewage. Medicine used by locals.	Release delayed several years while potential benefits investigated. Feasibility of utilisation found to be low and permission to release biocontrol agents granted.
Lantana camara **(Lantana)** USA	Horticulture – commercial growers of ornamental lantana in Florida opposed to biocontrol.	Request to release agents declined due to opposition from commercial growers. No agents released on mainland USA.

Weed and location	Possible adverse effects to:	Outcome
Leucaena leucocephala **(Leucaena)** South Africa	Wood industry – timber, fuel. Farmers – animal fodder.	Seed-feeding beetle released after considerable delay. Valuable seed plants could be protected from beetle relatively easily.
Opuntia ficus-indica **(Prickly pear cactus)** Hawai'i	Farmers – cactus used by ranchers as forage and source of water during droughts.	Biocontrol delayed for several years, poorer ranchers were able to develop better water systems and eventually a biocontrol agent was released.
Papaver sommiferum **(Opium poppy)** United Nations	Drug producers – immense monetary worth.	Agents found but not released because of international politics and violent retribution feared.
Passiflora mollissima **(Banana passionfruit)** Hawai'i	Hunters – feral pigs and the introduced Kalij pheasant (*Lophura leucmelana*) eat the fruit.	Biocontrol agents released. Destructive impact of the weed (and the feral pigs) far outweighed any benefits of the weed.
Pennisetum clandestinum **(Kikuyu grass)** Hawai'i, New Zealand	Farmers – forage in some regions.	Investigation abandoned in Hawai'i because of agricultural value. In NZ feasibility of biocontrol in early stages – likely to be opposition if taken further.
Pinus spp. **(Wilding pines)** New Zealand, South Africa	Wood industry – timber. Pines also commonly used as shelter belts and ornamentals.	More research into the safety and usefulness of biocontrol needed for NZ. Programmes for 3 pine species abandoned in SA – still searching for seed/cone-eaters for *P. pinaster*.
Prosopis spp. **(Mesquite)** South Africa	Farmers – shade, source of fuel, seed pods used for livestock fodder in arid areas. Apiarists – source of nectar.	Biocontrol delayed. Seed feeders eventually released. No other agents can be used so insufficient control – may become more acceptable in future as impacts of weed felt.
Rubus fruticosus **(Blackberry)** New Zealand, Australia	Horticulture – risk of damage to other berries. Apiarists – nectar useful.	Rust fungus blocked for several years in Australia, illegally released in 1984, and arrived in NZ in 1990. Investigations into additional strains of the rust are continuing.
Rubus strigosus, R. parviflorus, R. spectabilis, Canada	Horticulture – genetic contributions to breeding programmes, fruit, ornamental value. Stabilisation of banks and dunes.	Biological control research ongoing.
Salix spp. **(Willow)** New Zealand, Australia	Stabilisation, erosion and river control, shelter belts. Recreation – promoted as trout habitat. People like the look of them.	Biocontrol being considered, but opposition likely to be great. Several species (including crack willow) are still being planted.
Schinus terebinthifolius **(Brazilian peppertree)** Hawai'i, mainland USA	Apiarists – nectar important during winter. Horticulture – used as an ornamental, gardeners now realise adverse impact.	Considerable delay before agents released in 1950s. More needed but plant no longer spreading and opposition still strong. Release of agents on mainland USA imminent.
Solidago gigantea and S. canadensis **(Goldenrods)** Europe	Apiarists – good source of nectar. Horticulture – still sold in nurseries, widely used as ornamentals in gardens.	Biocontrol considered but abandoned because of opposition. Weed is still spreading.
Tamarix ramosissima **(Salt cedar)** USA	Horticulture – ornamental. Apiarists – food plant for honeybees. Hunters – nesting sites for game birds and doves.	Release of biocontrol agents delayed 4 years primarily because flycatchers nest in the trees.
Ulex europaeus **(Gorse)** New Zealand	Apiarist – valuable pollen source. Farmers – hedge, shelter plant, forage plant.	Considerable delay in revisiting the project in the 1980s, mostly due to apiarists. Six agents have been released since 1989.

Native pigeons (kererū) feed on many plants including weeds such as broom.

have occurred due to non-target conflicts. Two biological control agents have been released but an application to release a third, the broom leaf beetle (*Gonioctena olivacea*), was declined on the grounds that it attacked tagasaste (*Chamaecytisus palmensis*). There was insufficient information presented at the time on the value of this plant (which is promoted as a fodder crop, food source for native pigeons, and a nurse plant, but is also seen as a roadside weed by others) relative to the broom problem, and the actual risk the agent posed to tagasaste. Data on these issues is being gathered to strengthen a revised application.

Troublesome natives

"In parts of the world, the densities of some native plant species have increased substantially due to changes in land use and overgrazing, which has resulted in them now being considered weeds, e.g. bracken (*Pteridium aquilinum*), in Great Britain," revealed Margaret. Many native "weeds" in the south-western United States and in Canada have been proposed targets for biological control. Where a native plant species is targeted for biocontrol, the conflicts are often even more of a nightmare to resolve since their benefits are more numerous, the ecological effects complex, and the general public may have difficulty viewing native species as villains. Making changes to land use and more efforts to restore the original vegetation may be more appropriate in these situations than attempting biocontrol of native "weeds".

In New Zealand mānuka (*Leptospermum scoparium)* is sometimes seen as a weed by farmers of marginal land when it encroaches onto their pasture. However, this native plant is important in preventing erosion on steep hill country. It also plays a significant role in the regeneration of native forest, provides habitat for native fauna, and is a highly valued source of nectar. Recently it has been confirmed that mānuka honey has useful antiseptic properties. Large areas of mānuka began dying during the 1940s after a scale insect (*Eriococcus orariensis*) arrived from Australia. Conflict arose when farmers distributed infected plant material until the scale insect was widespread. Control of mānuka by the scale insect was extremely effective for some years until in turn a fungus (*Myrangium thwaitesi*) arrived under its own steam and attacked the scale insect.

Ecological questions

As native vegetation is cleared or taken over by invasive plants, then native animals increasingly turn to weeds for food and places to live. People worry that successful biocontrol could leave wildlife, including endangered or iconic species, without essential resources. However, Margaret concluded, "Species that cash in on weed invasions are usually common generalists that would not be driven to extinction by reducing or eradicating a weed." It also turns out that exotic weed species are not usually as good as native plants when it comes to providing resources for native animals. Even if a few native species are found to benefit from the presence of a weed species, overall biodiversity losses are still higher if weeds are allowed to continue to replace native vegetation.

There are some cases where threatened species have come to depend on weeds, e.g. the Mahoenui giant wētā *(Deinacrida mahoenui)* was found to be using goat-grazed gorse (*Ulex europaeus*) near Te Kuiti to escape predation by rats. However, in cases like this management techniques such as predator control, supplementary feeding, and providing nest boxes can be used to ensure the survival of threatened species.

Another issue complicating the release of biocontrol agents for broom (*Cytisus scoparius*) has been whether kererū (*Hemiphaga novaeseelandiae*) rely on the plant for food, particularly where there has been extensive clearing of native vegetation. Although kererū do consume broom leaves and buds, they eat lots of different plants and it turns out that feeding on broom is no picnic for them. Feeding low to the ground appears to be energetically more expensive than feeding up high in trees because of the need for increased vigilance and flights back to the trees between foraging bouts. There is also the increased risk of being killed by

stoats, or cars (where roadside broom infestations are involved). A reduction in broom density is therefore unlikely to have serious adverse consequences for kererū.

Nurse or curse?

In some situations, exotic plants can help native forest regeneration, particularly on highly degraded sites. Gorse and broom have been touted as good nurse crop species although there has been considerable disagreement as to their effectiveness in all situations. More recently, research has shown that although these weeds may facilitate forest restoration, successional pathways can be altered and you might not end up with the canopy tree species you are wanting. Margaret suggested, "More research is needed to quantify the benefits of using weeds as nurse plants, and their role in ecological processes should be explored before biocontrol is initiated."

Conflict resolution

Where conflict is thought to be likely, communication is the key to finding a way forward. It is vital to have full stakeholder participation from the beginning of a project and to maintain contact and information flow throughout. Often the most important point to convey to stakeholders is that biocontrol agents are very unlikely to eradicate the weed, that they will instead hopefully make it less invasive, and that this is not going to happen overnight. Sometimes exotic plants can still be utilised even where biocontrol has been overwhelmingly successful, such as when trees are controlled by seed feeders. If need be insecticides can be used to protect useful plants from highly effective seed-eating agents.

Margaret warned, "If adequate consultation does not occur, and if legal biocontrol using appropriate channels is made too difficult, expensive, or slow, there is a danger that individuals or groups who are suffering economic losses from weeds may act outside the law". This situation has already occurred in Australia with the illegal release of blackberry rust (*Phragmidium violaceum*), and enormously increases the risk of undesirable side effects occurring. A challenge for the future is to try to further improve consultation without making it too onerous.

Mahoenui wētā find gorse a safe haven from predators.

Cost–benefit analyses are also an important part of resolving conflicts of interest, particularly between two economic groups where monetary value can be estimated for the gains and losses to each party as a result of biocontrol. Decision makers often find arguments couched in monetary terms to be more convincing. It can be difficult to quantify the environmental and/or social benefits of biocontrol on natural communities. For example, South Africa's Working for Water Programme, which targets alien woody plants, creates job opportunities for the underprivileged as well as securing precious water resources (7% of South Africa's mean annual water runoff is lost through transpiration by alien plants).

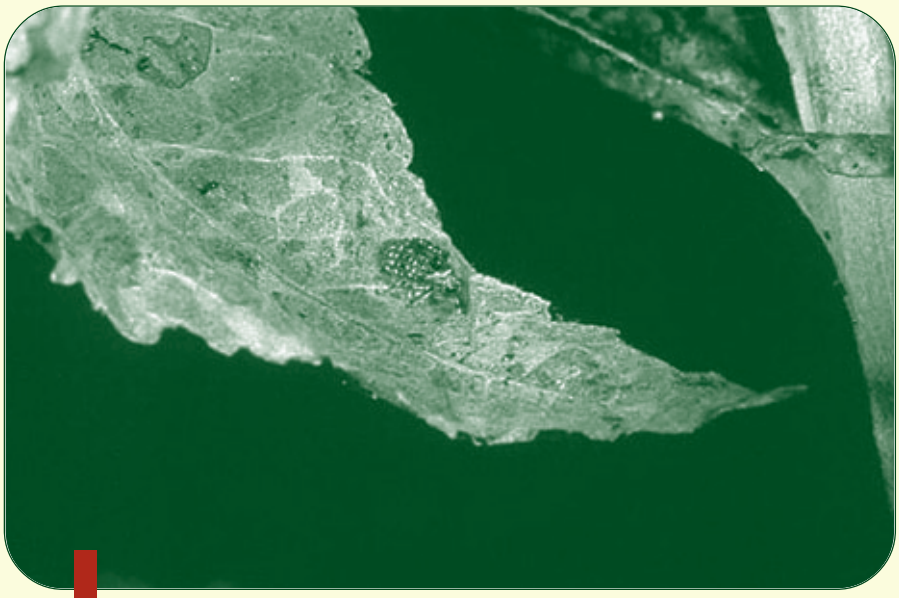
> "Where conflict is thought to be likely, communication is the key to finding a way forward."

Host specificity testing and risk assessment for most countries involved in biocontrol is now very time consuming and results in agents coming on stream more slowly. If it becomes necessary to assess subtle "ripple" impacts of biocontrol agents in native ecosystems, then biocontrol programmes could cease to exist because the research required would be prohibitively time consuming and expensive. While there is no such thing as a free lunch, biocontrol often remains the only safe, practical and economically feasible method of weed control that is sustainable in the long term. Margaret recommended, "It is important to resolve conflicts of interest promptly and minimise possible negative effects from biocontrol agents. Any serious delays or impediments could result in escalating weeds whose impacts are far worse than the risk biocontrol agents pose to the environment."

Margaret's postdoctoral study was funded by Landcare Research as part of its reinvestment scheme.

Predicting the Potential for Buddleia Biocontrol?

Buddleia (*Buddleja davidii*) is an attractive flowering shrub that comes from central China and now graces gardens in many countries. It is popular with butterflies and is known to many people as "butterfly bush". However, buddleia has a downside in that it produces copious amounts of wind-dispersed seed and has become widely naturalised in disturbed habitats. It particularly affects native ecosystems in places such as streambeds and landslips. In pine plantations on moist fertile sites young trees are unable to establish unless buddleia is controlled with herbicide. Forest Research staff have been investigating biocontrol for this target for a number of years, and have been focusing on a defoliating weevil (*Cleopus japonicus)* from China.



A Chinese weevil (Cleopus japonicus) *that attacks buddleia.*

"In the central North Island the weevil should be able to complete two or three generations each year."

The success of this weevil as a biocontrol agent will depend on its feeding behaviour, its capacity for population increase and dispersal, and how well its life cycle is synchronised with the seasonal development of buddleia. Forest Research staff are constructing a computer model to predict the likely future for buddleia if the weevil was released in New Zealand. Information has been gathered from China and from inside Forest Research's quarantine facility at Rotorua on the weevil's host specificity, life cycle, and feeding activity, and this has all been fed into the model. "Based on the information available to us at present the model predicts that in the central North Island the weevil should be able to complete two or three generations each year," reports Toni Withers of Forest Research. However, levels of population increase will also depend upon on how well it manages to survive the winter.

The feeding behaviour of individual weevil larvae has been scrutinised and, not surprisingly, it turns out that nearly full grown larvae and newly emerged adults have the biggest appetites. "Following a period of maturation feeding after emergence, older adults, who are known to live for over a year, eat surprisingly little (a mere 2–4 mm^2 of leaf tissue a day)," revealed Toni.

Buddleia in plots has been specially monitored at Rotorua so that the effects of insect feeding on its growth can be simulated and evaluated. Various amounts of foliage were removed manually at different times during last year's growing season (December–April), and the plants' vital statistics carefully noted too. "Initial results showed that severe defoliation does reduce plant growth, particularly above ground level, but that leaf damage must continue on after February for a sustained impact on the weed," explained Toni.

Earlier research has determined that a biocontrol agent would need to reduce buddleia growth upwards by at least 50% to make any difference to the shading of young pine (*Pinus radiata*) trees. Field research has not yet reached the stage of ascertaining the magic formula as to what leaf area needs to be lost to achieve this 50% reduction in buddleia height. When this has been established, then the next crucial research question will be what density of biocontrol agents will be required per plant, and over what periods of the growing season in order to achieve this level of leaf area reduction.

This project has been funded by the Foundation for Research, Science and Technology.

Things To Do This Summer

Hopefully you will all get a chance to have a holiday over the summer. However, as far as the work side of things goes, some activities that you might need to plan for include:

- Harvesting broom seed beetles (*Bruchidius villosus*) – you can redistribute the beetles while they are still inside the pods, but you need to keep a close eye on pod development. Do not harvest the pods until they are brown and mature, otherwise the beetles inside may not be mature. Don't delay once some pods have begun to burst.

- Harvesting cinnabar moth caterpillars (*Tyria jacobaeae*) – it has taken a decade for cinnabar moth to show its true colours in some parts of New Zealand and it is only now available in harvestable numbers in some places. The moth can be difficult to establish in some areas and the reason why is not always obvious. If you have been unsuccessful in a particular area in the past then it's probably better to try somewhere else. We would be interested to know if you find the moth in large numbers for our follow-up on non-targets work (contact Quentin Paynter paynterq@landcareresearch.co.nz).

- Checking gorse colonial hard shoot moth (*Pempelia genistella*) release sites – late spring is the best time to look for this agent, preferably before plants start to put on new growth, as the green and brown striped caterpillars and the webs they live in will be at their largest. Feeding damage and balls of frass should help you to distinguish these webs from spider webs. The webs remain obvious for some time over the summer after the caterpillars have pupated. Don't be too disappointed if you don't find anything as it took 4 years after we released the moths at Redcliffs before we could easily locate them again.

- Checking Portuguese gorse thrips (*Sericothrips staphylinus*) sites – it's best to check when gorse isn't flowering so you don't get confused by flower thrips (*Sericothrips obscuratus*). Look for the thrips by eye, especially on new growth – they are pretty tiny and you might need a hand lens if your eyesight isn't the best. If you can't see any then try gently beating some foliage over a piece of white cardboard. Don't disturb the bush any more than necessary.

- Checking on heather beetle (*Lochmaea suturalis*) release sites – unless heather beetles are present in large numbers and have caused a lot of damage they are likely to be hard to find. The adult beetles tend to drop to the ground when disturbed and the greyish-white larvae can also be hard to spot. You may need to beat heather plants with a stick over a white sheet, or try using a sweep net.

- Checking on hieracium gall midge (*Macrolabis pilosellae*) release sites – don't even try to look for the adults as they will be too hard to find. Instead check release sites for hawkweed plants with swollen deformities and curled leaves, which are caused by larval feeding.

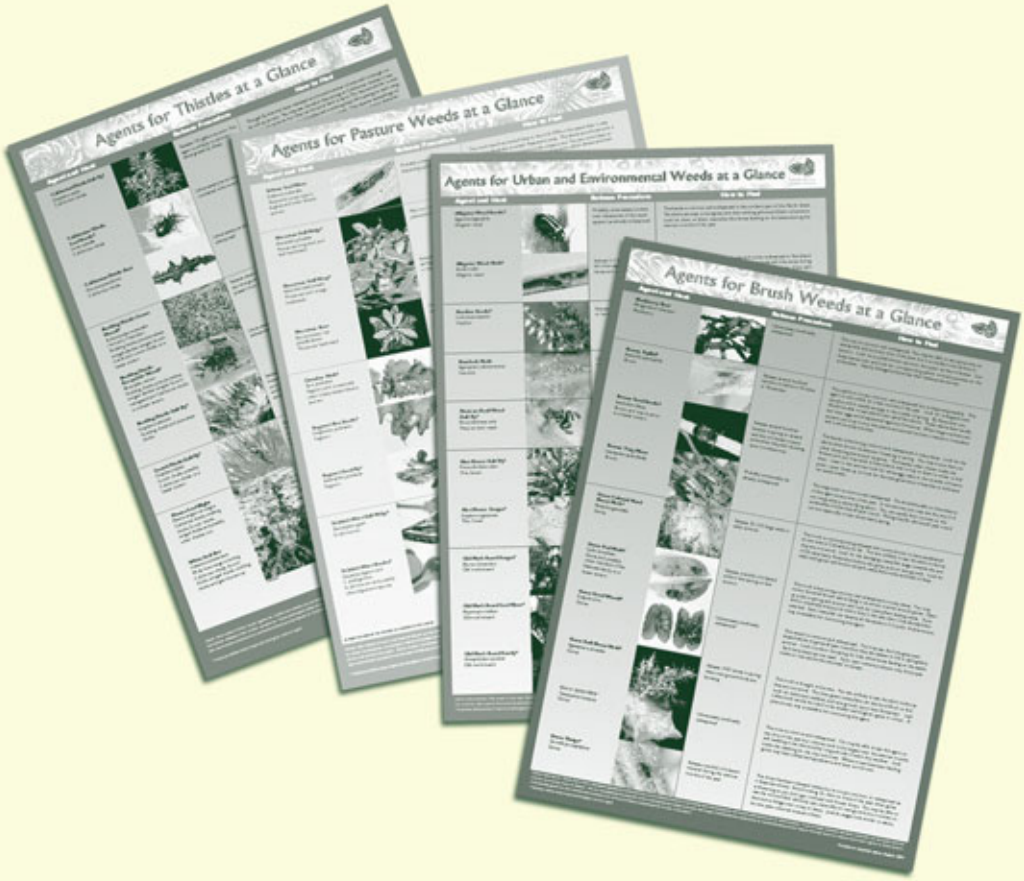
- Checking old man's beard saw fly (*Monophadnus spinolae*) release sites – this is a bit of an unknown quantity as we haven't yet managed to find them in the field in New Zealand! Our colleagues overseas tell us that the adults are not easy to spot but you can sometimes see the females sitting underneath the leaves or males swarming around looking for females to mate with. We suggest you look for leaves that have obvious feeding damage, particularly ones with semicircular incisions along the leaf margins or that have been completely skeletonised. The proof of the pudding, however, will be if you can find the culprit, so look out for the white caterpillar-like larvae. Good luck!

Remember to read up the relevant pages in *The Biological Control of Weeds Book* before embarking on any of these activities and let us know how you get on!

Old man's beard sawfly

Posters Galore

Due to popular demand we have dusted off the old "Agents for Biological Control of Weeds" poster that we produced back in 1995 and brought it kicking and screaming into the new millennium. There has been a lot of water under the bridge since we put the original poster together so this time round we have actually had to split it into four to accommodate all the new agents. So the line up now includes "Agents for Pasture Weeds/ Thistles/Brush Weeds/and Urban and Environmental Weeds at a Glance". These A3-sized posters are available free of charge. To place your order please contact Lynley Hayes (hayesl@landcareresearch.co.nz, Ph 03 325 6701 ext 3808).



A **one-day workshop** is planned for **Auckland** next year to give people the opportunity to update themselves on **what's happening in biocontrol of weeds** in New Zealand. The workshop will be free of charge and open to anyone who is interested in this topic and will feature presentations from a range of researchers working in this field, and hopefully some live exhibits. The workshop will be held at Tamaki and run back to back with a **weed ecology workshop**. The dates are likely to be 23–24 February. If you would like to register your interest in receiving more details about these workshops please contact Lynley Hayes (hayesl@landcareresearch.co.nz, Ph 03 325 6701 ext 3808).

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