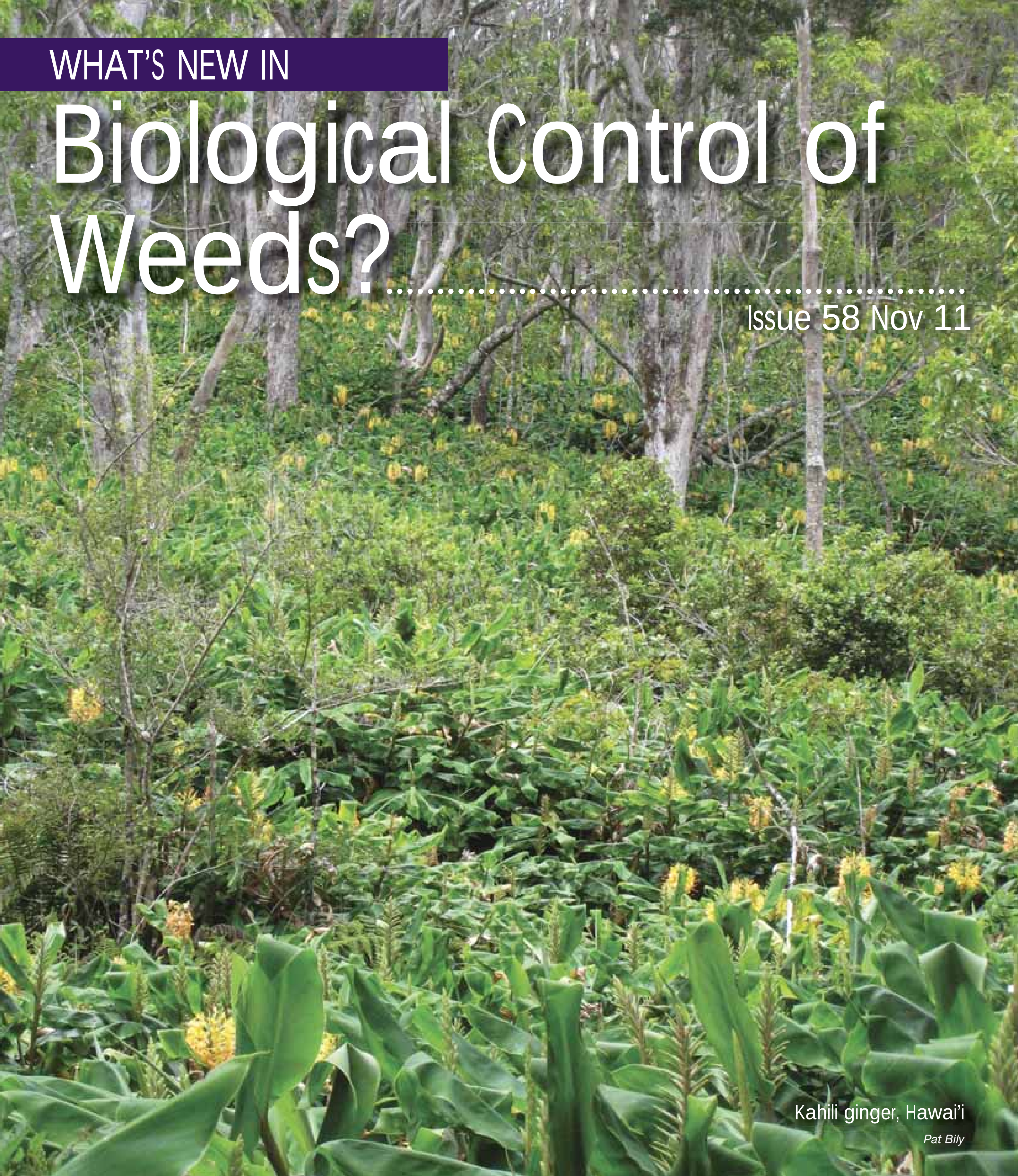
WHAT'S NEW IN

Biological Control of Weeds?

Issue 58 Nov 11



Kahili ginger, Hawai'i

Pat Bily

What's Inside?

Landcare Research
Manaaki Whenua

A Beetle for Moth Plant

An application has been made to release the first biocontrol agent for moth plant (*Araujia hortorum*) in New Zealand. Adults of the reddish-black beetle (*Colaspis argentinensis*) feed on the leaves but the real damage is caused by the larvae which attack the plant's roots. The beetle came to our attention while searching for damaging natural enemies in Argentina. Although its ecology is not well known this beetle is one of the most common natural enemies of moth plant and has only ever been observed on this host. Plant deaths have been seen in Buenos Aires province that have been attributed to attack by natural enemies, including root damage from this species. "Females lay eggs around the base of the plant stem and larvae hatch and burrow down to feed in the root zone," said Hugh Gourlay, who has been studying the beetle. While the impact of the beetle on moth plant has not been studied in South America, other species of *Colaspis* with root-feeding larvae are significant pests elsewhere. The fact that other beetles in this genus can build up to sufficient numbers to significantly damage their host plants raises our hopes that the moth plant beetle can do so too.

Moth plant beetle.

"With so little known about the beetle it has been a huge learning curve to work out how to rear and host test it," said Hugh. Adult beetles appear relatively long-lived and one female may lay several hundred eggs over her lifetime. In containment conditions it takes 30–40 days for a beetle to develop from egg through to adult, suggesting that it may be able to complete two generations a year if released in New Zealand. Testing showed that the beetle is specific to plant species within the subtribe Oxypetalinae of the plant family to which moth plant belongs (Apocynaceae). The only species other than moth plant that the beetle is likely to attack in New Zealand is tweedia (*Oxypetalum caeruleum*), an old-fashioned ornamental plant. Another close relative, swan plant (*Gomphocarpus* spp.), the favourite host of the monarch butterfly, is not at risk of attack, nor are any native plants. These test results allowed an application to be made to the Environmental Protection Authority (formerly ERMA) in September with the Waikato Regional Council as applicant. We expect to have an answer before the end of the year.

Hugh has also been studying another potential control agent for moth plant, a fruit fly (*Toxotrypana australis*) that attacks moth plant pods. The female sticks her long ovipositor into the pods and lays eggs inside. "Feeding by the developing larvae turns the insides of the pods to mush so no viable seeds are formed," said Hugh. There is little known about this fly including how to rear it, but we hope to be able to host-range test it soon, seeing as it is such a promising agent. Getting all the test plants to produce pods at the right time will be another challenge.

Progress on a third species of interest for moth plant, the rust *Puccinia araujiae*, has been very slow. Unfortunately, our colleagues at the Universidad Nacional del Sur, Argentina, who are working with us, lost their colony of rust and had to re-collect it, delaying testing. We have also been having difficulties getting permission to send seeds of test plants to Argentina for testing the rust. Thanks to the assistance of the Argentinean consulate in New Zealand the seeds were finally allowed into Argentina in June, and plants are now being grown on and should be large enough for testing soon.

This project is funded by the National Biocontrol Collective.

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What's Bugging the Boneseed Leafroller?

Scale insects may be the cause of difficulties in establishing the boneseed leaf roller (*Tortrix* s.l. sp. "*chrysanthemoides*"). The moth has failed to establish at some sites, including all South Island sites, and is only common at three release sites in the North Island (in Northland and the Bay of Plenty), where moths are easy to find but not causing a lot of damage just yet.

The total failure of South Island releases initially suggested that climate might be the cause, but overwintering experiments set up in late autumn are indicating otherwise. The survival of boneseed leafroller larvae was monitored monthly at three sites in the North Island and three in the South Island. "Larvae, protected from predators in mesh sleeves, survived the polar blast that came through in July with freezing temperatures and widespread snow," said Quentin Paynter, who led the study. Data up to the end of August indicate similar overall survival and developmental times of larvae at North and South Island sites. We will keep monitoring the larvae until they complete their development.

Predation by wasps, and ants to a lesser degree, does appear to be limiting the boneseed leafroller. But where do the scale insects fit in? Boneseed (*Chrysanthemoides monilifera monilifera*) is often host to scale insects which produce honeydew as they feed on sap. This honeydew attracts wasps and ants which then also prey on vulnerable leafroller caterpillars. When leafroller release sites were surveyed for establishment a record was also kept of scale insect abundance. "We found that establishment success was almost 70% at sites with no scale insects but dropped rapidly to zero where scale insect abundance averaged over about two per gram of foliage (dry weight)," said Chris Winks. All sites were exposed to predators but it seems it is the presence of scale insects that draws them in. To examine this relationship in more detail we conducted an exclusion experiment at a site with abundant scale insects. The results showed that under normal conditions leafroller larval survival was zero. However, where wasps and ants were excluded using sleeves and sticky barriers larval survival was high. Scale insects occur patchily on boneseed throughout the country and can vary in abundance from year to year. It is not feasible to control them, or minimise predation, so it is important to not waste resources releasing more leafrollers at sites where they have already failed to establish.

Parasitoids are also putting the pressure on some boneseed leafroller populations. We know of at least four species, native and introduced, that attack leafroller eggs and larvae. "While

Boneseed heavily infested with scale insect.

we have not quantified their effect on leafroller establishment and population growth, it seems likely that parasitoids are limiting the moth's impact on boneseed at sites where predation is less intense," said Quentin. We are not aware of any research about interactions between the leafroller and scale insects in its native range in South Africa but the leafroller is heavily attacked by predators and parasites there and, despite this, still manages to outbreak and severely damage boneseed in some years. We are hopeful that it will still be able to do the same here.

Other agents that are not affected by the presence of predators will be important for areas where the leafroller is not able to establish. In this light, work is continuing in South Africa on the boneseed rust (*Endophyllum osteospermii*), although its long life cycle is making testing challenging. It can take up to 3 years before symptoms of the rust show up on infected plants. Our colleague, Dr Alan Wood (PPRI), tried to speed up testing by studying the interactions of infection at the cellular level but this has not been successful, so he inoculated test plants and we waited to see what happened. Unfortunately, the test plants inoculated with the rust to act as positive controls did not become infected in sufficient numbers, which means that we cannot be certain that other negative test results are valid. The only thing to do was try again and a new set of plants were inoculated late last year. In the meantime all we can do is be patient.

Funding for the leafroller establishment project was provided by the Ministry of Science and Innovation funded Beating Weeds programme.

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Weed Biocontrol on the World Scene

In September around 200 weed biocontrol practitioners from nearly 30 countries descended on the Big Island of Hawai'i for the 13th International Symposium on Biological Control of Weeds. This conference is held every 4 years or so and is an extremely important forum for refining international weed biocontrol best practice and developing new collaborations. Because classical weed biocontrol projects always involve work overseas, and weeds come from all over the world, it is essential to have a wide variety of international collaborators to call on for assistance! In the spirit of such collaboration Hugh Gourlay, with his considerable experience at organising such an event, went over a couple of weeks early to help the Symposium Committee with what proved to be a highly productive and enjoyable event.

Before the symposium kicked off a one-day workshop was held for plant pathologists to talk about challenges and advances in the development of bioherbicides for weeds. Stan Bellgard attended this meeting and presented a paper outlining the pathogens found on pampas (*Cortaderia* spp.) in New Zealand and Argentina to date, and an assessment of their likely suitability as candidates for bioherbicide development. Sadly, with one possible exception, which will be studied further, there appear to be no suitable candidates at present.

Although New Zealand is a small country with a modest budget for weed biocontrol it continues to more than hold its own on the international stage, and consequently our group was given a number of speaking slots. First up Lindsay Smith told the conference about the epic battle to free the tradescantia leaf beetle (*Neolema ogloblini*) of gregarine gut parasites. Tradescantia is an up and coming weed in a number of countries and there was considerable interest now that New Zealand has started releasing agents against this target. Later that day Richard Hill presented a paper he co-authored with Landcare Research and Environmental Protection Authority staff, about the New Zealand system for introducing new biocontrol agents and why it works so well at a time when other countries are struggling to get new agents approved. Many believe the New Zealand system to be the best and most comprehensive system in the world for considering new introductions.

Workshops were held in the evenings so smaller groups could discuss topics of interest in more detail. A popular workshop held on the first day was one where the notion that classical biocontrol is an old science paradigm that is losing its way was debated. Biocontrol has had some bad press in countries like the USA, where agents have been released in the knowledge they were not sufficiently specific, with the inevitable consequences. This, along with an international trend of growing distrust in science and government, is making it challenging for the work to continue in some countries. Does classical biocontrol need to change its paradigm in response to changing societal values? Will climate change undermine successes? Can we do more to ensure lasting success? An example was given of a programme where a weed had been well controlled by biocontrol agents only to be replaced by other weeds. The take-home message here is that we need to take a much more holistic approach to weed problems. We need to think more about what needs to be achieved. Is biocontrol the best option? What might happen if biocontrol is successful? What other management may need to be undertaken to ensure a weed is replaced with desirable vegetation? This is a conversation weed biocontrol practitioners and land managers in New Zealand need to start having.

Invasive fountain grass on the Big Island.

Another workshop focused on a problem that is beginning to cause much concern within the international biocontrol community. The Nagoya Protocol on Access and Benefit-Sharing (ABS) is a new international treaty adopted in October 2010 under the auspices of the Convention on Biological Diversity (CBD). Its objective is the fair and equitable sharing of benefits arising from the utilisation of genetic resources, thereby contributing to the conservation and sustainable use of biodiversity and implementation of the objectives of the CBD. Although the protocol is not yet officially in force, because 50 countries have not yet ratified it, some countries are already imposing tough new regulations around granting permits to import, collect, or export material. Working through the processes required to get permits is often taking a year or longer, leading to additional costs and delays to projects. There is also a suggestion that some countries may now require tangible benefits if they share material with other countries, including financial contributions if successful biocontrol results in economic benefits. There are no easy solutions to these challenges, and the workshop agreed to put together a survey and to form a working group to address the problem.

On day two Quentin Paynter spoke about our project to predict which agents are most likely to be parasitised (see Issue 49). This project has yielded significant insights (e.g. avoid agents that are highly parasitised in their native range and have native congeners) that can be used immediately by the international community to reduce wastage of agents due to parasitism. That evening a poster session was held to which our group contributed the following:

- Feasibility of biocontrol for tutsan in New Zealand
- Prospects for biocontrol of Darwin's barberry in New Zealand using Chilean seed predators
- An overview of species that have been brought into our containment facility and their fate
- Endophytes associated with Californian thistle and their influence on biocontrol
- Predicting how fast a biocontrol agent will disperse

On the third day we went out into the field to learn about examples of successful biocontrol on the island, e.g. banana passionfruit (*Passiflora tarminiana*), ivy gourd (*Coccinia grandis*), lantana (*Lantana camara*), mist flower (*Ageratina riparia*), pricky pear (*Opuntia* spp.), and St John's wort (*Hypericum perforatum*). It was also an opportunity to learn more about some of the weed problems Hawai'i is still battling, e.g. African tulip tree (*Spathodea campanulata*), albizzia (*Falcataria moluccana*), Asian melastome (*Melastoma septemnervium*), Brazilian pepper (*Shinus terebinthifolius*), cane tibouchina (*Tibouchina herbacea*), emex (*Emex australis*), fire tree (*Morella faya*), fireweed (*Senecio madagascariensis*), fountain grass (*Pennisetum setaceum*), gorse (*Ulex europaeus*), Kosters curse (*Clidemia hirta*), miconia (*Miconia calvescens*), strawberry guava (*Psidium cattleianum*), and wild ginger (*Hedychium* spp.), to name some of the worst offenders. The wild ginger infestations at Volcano National

Strawberry guava infestation.

Park were impressive and it was heartening to hear again at the conference that good prospective biocontrol agents exist in the native range (see also Issue 57). A promising biocontrol agent has recently been found for strawberry guava, which could reduce the speed at which the plant spreads or reinvades cleared areas. It is a scale insect (*Tectococcus ovatus*) that galls the plant, limiting fruit production. Unfortunately a local activist has strongly protested on dubious grounds and played some clever politics, and as a result the scale insect cannot be released at present. Strawberry guava is naturalised in New Zealand, and is one we should be keeping a close eye on.

Gorse is a weed we are clearly familiar with, and some conference attendees visited a serious infestation (estimated to be about 3,000–4,000 ha) which is continuing to get worse with time. The gorse seed weevil (*Exapion ulicis*), thrips (*Sericothrips staphylinus*), spider mite (*Tetranychus lintearius*), and soft shoot moth (*Agonopterix umbellana*) have all been established as biocontrol agents there, but are not exerting sufficient control at present. Extensive efforts involving spraying and burning have also failed to stop the gorse from spreading. Future plans are to add more pressure to the gorse by releasing the gorse pod moth (*Cydia succedana*) and having another go at establishing the colonial hard shoot moth (*Pempelia genistella*). The jury is out as to whether biocontrol will be able to have sufficient impact, and there is also a long-term plan to plant trees in heavily infested areas, which will in time shade out the gorse.

On day four Simon Fowler shared the outcomes of a study to look at the potential impacts of climate change on weed biocontrol in New Zealand. While there is a lot of hand-wringing about climate change at the moment it is comforting to think that efforts going into weed biocontrol in New Zealand seem unlikely to be majorly disrupted over the next century (see Issue 53). That evening a workshop was held to reflect on communication strategies, especially when faced with the sort of opposition to biocontrol they are experiencing in Hawai'i. This followed on from a talk given earlier in the day by Keith

Ronny presenting her paper.

Warner, University of Santa Clara, who made the case that we need to make a clearer to distinction between researcher roles and public engagement roles. Scientists are often not the best people to undertake communication with end-users, and beneficiaries of the research are the best people to argue that a weed needs to be controlled and that biocontrol is the best option. This is also something we need to give more thought to in New Zealand.

On the final day of the conference Ronny Groenteman presented her retrospective study into St John's wort beetles (*Chrysolina* spp.). She has found that host-testing indoors overestimates the likelihood of non-target attack in the field by these beetles, confirming that we can potentially reject good agents unless we can develop more sophisticated testing methods (See Issue 55). Finally Paul Peterson explained about the project to assess the impact of the heather beetle (*Lochmaea suturalis*). This study also caught the delegates' attention as it clearly showed the outcome of a range of control options including biodiversity benefits arising from biocontrol. The trial has shown that if you do nothing the heather (*Calluna vulgaris*) gets worse. If you spray the heather with herbicide, which is expensive, you eventually kill it but you also get changes in plant composition such as an increase in exotic grasses, as other desirable plants are also killed. Finally, heather beetles, when populations build to sufficient levels, can kill heather very quickly without harming other plants.

Compared to previous symposia there appeared to be increased attention given this time to the socio-political issues already discussed, plant chemistry, evolution, choosing targets, and grasses. Plant chemistry provides the basis for the host specificity that allows us to undertake biocontrol. Insects that develop a close relationship with a plant are able to deal with the chemicals that the plant produces as a defence mechanism to avoid herbivory, and even use them as cues to recognise host plants. Plants produce different compounds to deter specialist and generalist herbiviores, and need to make trade-offs. Studies have been looking into whether plant defence chemical profiles change in the presence or absence of natural enemies and there is some evidence they do. There is also a suggestion that studying the chemistry of plants could be a useful indicator of host specificity in some cases.

The risk that biocontrol agents will be able to evolve over time (hundreds of thousands of years) to exploit new hosts has always been acknowledged as possible but considered low risk. Specialists tend to have low genetic variation in relation to host use, so it is not easy for them to evolve to attack new hosts. There is always the possibility of a mutation occurring but the conditions that would allow it to proliferate are not often met. For example, unless gene flow is severely restricted, any new mutation is likely to be rapidly swamped by existing genetic material. Andy Sheppard, CSIRO, in an overview paper concluded that a host shift was most likely for polyphagous or oligophagous species (many or several hosts), rather than the highly host specific monophagous species we tend to utilise in biocontrol. Also any host range expansion is only likely to occur within the organism's fundamental range (i.e. things it can attack if forced but doesn't if given a choice), which will be in the same genus, family or tribe. The risk of a host shift down the track can be minimised by sticking to highly specialised agents, studying genetic variation of potential agents, and gaining an understanding of fundamental versus realised host ranges. There is evidence that some biocontrol agents can adapt over time to be more suited to local conditions, which is clearly a good thing. For example, Peter McEvoy from Oregon State University has shown that ragwort flea beetles have a shorter diapause in parts of the USA where the growing season is shorter.

A paper given by Bernd Blossey of Cornell University demonstrated some of the difficulties around choosing suitable targets. He has studied a weed called garlic mustard (*Alliaria petiolata*) that has become sufficiently troublesome in forests in parts of the USA for biocontrol to be explored and agents identified, which have not yet been released. At his study site Bernd and colleagues have shown that the weed does not have major impacts on the ecosystem it invades, and naturally begins to decline after a period of time. This was provided no active control was undertaken to remove adult or rosette plants, which served to perpetuate the weed problem. It is thought the natural decline is due to a negative soil feedback mechanism, but the organism responsible has not as yet been identified. So it is possible that the biocontrol agents may not be needed after all, and that the only management needed is to control plants colonising new areas. But can the results be extrapolated to other soil types, other parts of the USA and will the situation change in the future? How much data do we need and how long can we wait until we decide to act on a weed, and how much damage might be done before a weed population collapses on its own, if it does at all? All interesting questions, as is could we ever secure the resources to undertake such pre-release ecological studies of weeds in New Zealand?

Previously it was considered that grasses would be too difficult for biocontrol, but the Australasian programme against Chilean needle grass (*Nassella neesiana*) and an American programme against giant reed (*Arundo donax*) have shown this is not necessarily the case. The island of Maui has a major problem with purple pampas (*Cortaderia jubata*) so they are watching our efforts to find biocontrol agents for this species with interest. Don Sands of CSIRO talked of the issue in Australia with a number of African grasses that accumulate large amounts of biomass and become a big fire risk, and posed the question whether biocontrol agents that target just this dead material could be considered (in a similar way that dung beetles remove dung). There is not a lot known about species that could be used in such a way but if they were only targeting dead material then perhaps they would not have to have a narrow host range?

While Hawai'i remains a beautiful and intriguing place to visit, the challenges facing the country in terms of invasive species are mind boggling. The only intact native vegetation not compromised by invasive species is found on the tops of high mountains. A Hawaiian researcher, Art Medeiros, questioned whether any of Hawaii's native biodiversity would be able to survive into the next century, adding that the battle was close to being lost and biocontrol clearly now the only possible answer. However, with a general public that appears apathetic about invasive species combined with elements that are strongly opposed to biocontrol, a lack of legislation to protect biodiversity, and funding cuts eroding biosecurity efforts it is currently difficult to see how Hawaii's unique biodiversity will be saved. Even in New Zealand where we do have good legislation, support for biocontrol, and a strong biosecurity system, it has been suggested in a recent analysis that we need to be investing 9–25 times more money in order to halt biodiversity decline. Clearly weed biocontrol is going to be needed even more desperately in the future, while possibly facing stiffer obstacles, so international symposia where weed biocontrol practitioners can get together to swap ideas will continue to be of critical importance.

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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
- Broom Divider
- Buddleia Leaf Weevil
- Californian Thistle Divider
- Gorse Colonial Hard Shoot Moth
- Gorse Soft Shoot Moth
- Heather Beetle
- Nodding Thistle Divider
- Ragwort Divider
- Ragwort Crown-Boring Moth
- Ragwort Plume Moth
- Tradescantia Leaf Beetle
- Tradescantia Leaf Beetle Release Sheet
- Woolly Nightshade Lace Bug Release Sheet

Workshops

A basic biocontrol workshop is being held at Lincoln on 14–15 December 2011. Also an advanced biocontrol workshop will be held in Auckland in March–April 2012 if there is sufficient interest. If you would like to attend either workshop, and have not already sent through an expression of interest, please contact Lynley Hayes (hayesl@landcareresearch.co.nz).

Summer Activities

Longer days and rising temperatures trigger a busy stage in the life cycles of many of our biocontrol agents. Some activities to fit in during these warm months include:

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

- Check release site for shelters made from curled leaves tied together with webbing at the stem tips and sprinkles of black frass. Caterpillar feeding makes "windows" in the leaves where they have eaten the green tissue away and the leaf may be turning brown. We would be very interested to hear of any instances of severe damage to the foliage.
- If you find large numbers of caterpillars you can begin harvesting and shifting them around. Cut off boneseed tips with webbing and wedge them into plants at the new site. Aim to move 500 caterpillars. Do not choose a site where scale insects or ants are present (see *What's Bugging the Boneseed Leafroller?*, page 3).

Broom leaf beetle (*Gonioctena olivacea*)

- Check release sites for larvae feeding on the shoot tips and leaves and for adult beetles. Adults are small (2–5 mm), the males have an orangey-red tinge and the females are orangey-brown, although colouration can be quite variable. If you can't see any, try 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.

Gorse soft shoot moth (*Agonopterix ulicetella*)

- Check release sites now as by late November–early December the caterpillars are quite large but have not yet pupated. Look inside webbed or deformed growing tips for dark brown or greyish-green caterpillars. We would be very interested to hear of any outbreaks or caterpillars found in new locations – areas of particular interest are the North Island and lower South Island.
- Redistribute caterpillars by harvesting infested branches or even whole bushes.

First tradescantia beetle to be recovered in the field, Mt Smart 6 months after release.

Green thistle beetle (*Cassida rubiginosa*)

- Check release sites for windows eaten into the leaves. Adults are well camouflaged being green so it may be easier to spot the larvae, which have a distinctive protective covering.
- If you find beetles in good numbers you can begin harvesting and shifting them around. We expect the best way to collect beetles is using a garden-leaf vacuum machine. Aim to shift at least 50 adults in the spring. Make sure you separate them from the other material collected during vacuuming so you don't spread pasture pests.

Tradescantia leaf beetle (*Neolema ogloblini*)

- Although release sites are all very new it might be worth looking for leaves that have notches in the edges caused by adult feeding or which have been skeletonised by larvae grazing off the green tissue. You may see the dark metallic bronze adults but they tend to drop or fly away when disturbed. It may be easier to spot the larvae, which have a distinctive protective covering over their backs. Young larvae are gregarious and may be seen in packs forming feeding fronts. Older larvae feed individually. The pupal cocoons are extremely unusual (white, star-shaped and resemble styrofoam) and may be visible on damaged foliage. We would be very interested to hear if you find any sign of the beetles.

Woolly nightshade lace bug (*Gargaphia decoris*)

- Check release sites for white chlorotic spots on the leaves and speckles of black frass along the leaf margins. You might see dark egg batches on the pale undersides of the leaves, or the pale brown adults or nymphs that both tend to cluster in groups – we would be very interested to hear if you do.
- We are unsure if populations will be big enough for you to begin harvesting and shifting lace bugs around yet, but if you find large numbers then go for it!

www.landcareresearch.co.nz

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