What's New In Biological Control Of Weeds?

Issue 43 February 2008

Landcare Research
Manaaki Whenua

What's Inside:

ISSN 1173-762X

A Number of Firsts

A lot of really exciting developments have occurred in recent months with a number of significant first-time events.

Application lodged to release first tradescantia biocontrol agent

Auckland Regional Council has submitted an application to ERMA for the release of the tradescantia leaf beetle (*Lema obscura*). This is the first biocontrol agent put forward for this weed in New Zealand and it is only expected to attack tradescantia (*Tradescantia fluminensis*). We expect to hear by April if permission to release has been granted. Two other closely related beetle species have been identified as promising candidates and are being studied further. *Neolema abbreviata* attacks the growing tips, and *L. basicostata* bores into mature stems. It is expected that the three beetles between them could provide a comprehensive and concerted attack.

First releases of new thistle agent

The first releases of a new agent to target Californian thistle (*Cirsium arvense*) have been made in Otago and Southland. After 10 years of effort put in by the Californian Thistle Action Group, CABI Bioscience, and Landcare Research, the green thistle beetle (*Cassida rubiginosa*) was released near Lawrence and Invercargill in November. The adult beetles were released in hot spring conditions and flew off to find thistles as soon as their box was opened. Both adults and larvae eat leaf material and while they favour Californian thistle they are likely to attack all thistle species to some extent. Widespread releases are planned for next spring.

New broom agent establishes

The broom leaf beetle (*Gonioctena olivacea*) has been seen at one of the first sites it was released at in North Canterbury. After

Tradescantia leaf beetle larva - note protective coating on back.

much searching both eggs and larvae were discovered on plants that had been planted out in February last year (see *New Broom Agent Unleashed*, Issue 39). "The adults are out and about laying eggs earlier than I expected," said Hugh. Larvae have also been found at our release site at Lincoln. The first widespread releases of this beetle got underway last spring.

New ragwort agent establishes

We have had our first evidence that the ragwort plume moth (*Platyptilia isodactyla*) is successfully establishing here. We checked a site near Marton at the end of October where they had been released a year before and found large larvae all over the release paddock. "About 70% of the plants we checked had one or more large plume moth caterpillars on them, chomping away at the weed," said Hugh Gourlay.

Hugh spent some time checking other plume and crown-boring moth (*Cochylis atricapitana*) release sites around the country. After 3 days of intensive searching for signs of establishment of these agents on the West Coast he finally found one plume moth pupa at the very last site he checked, at Inchbonnie! However, Caryl Coates of the West Coast Ragwort Control Trust reports having found larvae at sites in Reefton and Arahura. Walter Stahel of Environment Bay of Plenty has also seen larvae at one of his Whakamarama release sites.

More releases of both these agents were made before Christmas.

Boneseed leafroller shows early promise

The boneseed leafroller (*Tortrix* s.l. sp. "chrysanthemoides") seems to be off to a good start. All the worst affected regions have received releases this spring. Chris Winks recently checked sites in Northland and Wellington where adult moths had been released a few months before and could easily find small to medium-sized caterpillars webbing shoot tips together. "At two of the sites, several of the boneseed bushes examined had caterpillars in more than half of their shoot tips," said Chris. "It's very promising to see this level of infestation already." Good reports have also come in relating to three Auckland sites. Now we just need to see if the leafrollers can make it through the winter.

Farewell to Nick

It was with much sadness that we farewelled pathologist Nick Waipara in January. Nick has left Landcare Research to take up a science strategy position with Auckland Regional Council. In the 5 years that he was with us Nick worked on a wide range of projects including seeking suitable agents overseas for banana passionfruit (*Passiflora* spp.), barberry (*Berberis* spp.), gorse (*Ulex europaeus*), lantana (*Lantana camara*), moth plant (*Araujia sericifera*), tradescantia (*Tradescantia fluminensis*), and wild ginger (*Hedychium* spp.). As well as undertaking surveys to check for non-target damage caused by pathogens in New Zealand (none was found) he also helped us to document and evaluate the usefulness and impact of pathogens already in New Zealand on bridal creeper (*Asparagus asparagoides*), Californian thistle (*Cirsium arvense*), Japanese honeysuckle (*Lonicera japonica*), old man's beard (*Clematis vitalba*) and wild ginger. Nick also supervised several students and worked on projects to explore the potential for developing mycoherbicides for aquatic and woody weeds.

Nick setting out trap plants in Brazil.

If all that wasn't enough Nick was also the friendly guy who would look at diseased plants of interest that people had come across, and let them know what they had found. In future if you wish to send in diseased weeds (and we are always happy to receive them) please contact Sarah Dodd (dodds@landcareresearch.co.nz, Ph 09 574 4103). With perishable items it is always important to contact us prior to sending them!

Thanks Nick for your dedication and all the hard work that you have done. We wish you all the best for the future.

Back from the Dead

Between 1990 and 1995 we reared and released nearly 30,000 Californian thistle leaf beetles (*Lema cyanella*) at 37 sites throughout New Zealand. It was a huge effort so we were very disappointed when no trace of the beetles was ever seen again at most of the sites, and only a handful were glimpsed at a few sites before appearing to die out. By 2000 the beetles could only be found at one site, near Wellsford, Auckland, but still only in low numbers (one adult and 20 damaged plants found after a great deal of searching). We were puzzled by the spectacular failure of this agent (and the very similar Californian thistle flea beetle (*Altica carduorum*), which failed to establish at all), and decided to go in search of better agents for Californian thistle (*Cirsium arvense*).

However, curiosity got the better of us and last summer we went back to take another look at the Auckland site. Dave Galloway of Auckland Regional Council, who accompanied Chris Winks, said, "We went along with a this-will-possibly-be-a-waste-of-time attitude but very quickly got excited when we found some adults about 300 m from the release point." Most of the Scotch (*Cirsium vulgare*) and Californian thistles in the area showed signs of damage and both adults and larvae were easy to find.

We were puzzled by the spectacular failure of this agent

Another check this summer found the beetles continuing to thrive at this site and build in number. "The damage was even more noticeable with some plants now being severely defoliated," reported Chris. "This time we noticed they were attacking winged thistles too (*Carduus tenuiflorus*)." Like many thistle biocontrol agents this one will attack a range of thistle species, although Californian thistle is the preferred host.

Chris Winks strikes gold! Note beetle larva sitting under leaf.

Now that the beetle is showing some promise, attempts will be made to collect adults from this site and establish them in other areas. We know that the beetles have been on the move, as we picked up one during our recent ginger survey at a site 20 km away. So we expect people will find them at other sites in years to come; keep a look out for them – late spring and summer are the best times to look. The metallic bluish-black adults can be hard to see as they tend to drop to the ground when they detect movement so look instead for the grey slug-like larvae and the feeding damage (windows in the leaves). We would be very interested to hear if you stumble across some (contact Lynley Hayes: hayesl@landcareresearch.co.nz).

There is no obvious reason as to why the Auckland site succeeded where 36 others did not. The most noticeable thing is that this was the most northern release site and is therefore possibly the warmest. There are perhaps some similarities here with the problems we have been having with the heather beetle (*Lochmaea suturalis*) (see *"Big is Sometimes Best"*, page 4), which has done best at the warmer sites. But we are a little suspicious now that there may have been a synchronicity problem with the Californian thistle beetles perhaps becoming active in the spring too soon for their preferred host, and that they have needed to slowly adapt to our conditions. Further research is needed to get to the bottom of this mystery and may yield further wisdom that could help us to successfully establish other tricky agents in the future.

Big Is Sometimes Best

Over the past decade heather beetles (*Lochmaea suturalis*) have been released at high altitude sites on the Central Plateau of the North Island (Tongariro National Park and New Zealand Army land), at sites near Rotorua, and more recently at low altitude sites adjacent to Tongariro National Park. Establishment at high altitude sites on the Central Plateau has been poor, and until recently, beetles have only significantly damaged heather at one site before the population collapsed. Conversely, establishment success at Rotorua has been excellent with heather being consistently damaged or killed over time. Early indications suggest establishment at low altitude sites adjacent to Tongariro National Park is going to be better than nearby high altitude sites.

We have ruled out predation, parasitism, and disease as the reasons for the poor performance of the beetles in the Central Plateau, where the heather (*Calluna vulgaris*) problem is most serious. We now suspect that poor heather beetle establishment may be linked to climatic conditions and be exacerbated by small adult body size.

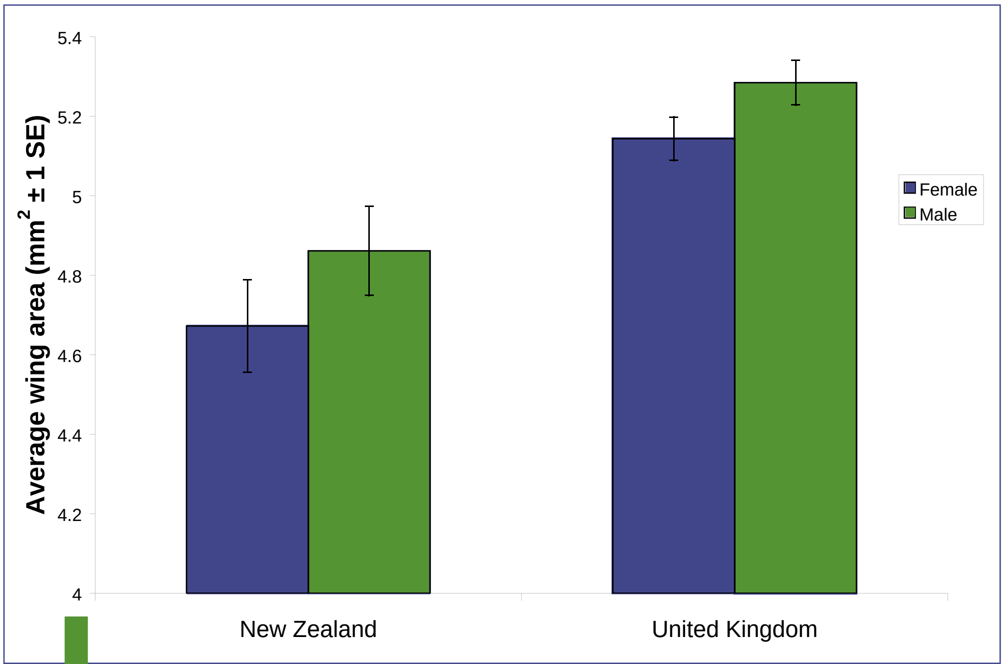
We have measured lots of beetles and found that New Zealand ones are smaller than beetles from populations where they were sourced in the UK (see graph). Not only does beetle size vary between countries but within the UK beetles are larger at higher latitudes, where it is colder. "We know from experiments on beetles in the lab that bigger beetles do have proportionally more fat reserves," explained Paul Peterson. Therefore we thought that it might be harder then for small beetles to survive the winter.

We now suspect that the problem is our topsy-turvy spring

However, recent experiments have shown that survival over the winter does not appear to be affected by body size. We now suspect that the problem is our topsy-turvy spring when it can be hot one minute and cold the next. Recent experiments have confirmed that survival is poor when beetles are exposed to a cold snap once they have come out of hibernation.
Small beetle size may be due to low genetic diversity or poor nutrition.
Line rearing of the beetles to remove a microsporidian disease in quarantine may have reduced genetic diversity, and we have started work to compare the genetic make-up of New Zealand and UK beetles. We are also checking the nutritional status of heather from both countries, and seeing what happens when we add nitrogen fertiliser (urea @ 30 kg/ha). Two spectacular heather beetle outbreaks following the addition of nitrogen suggest we may be on to something, but more time is required to assess this experiment.

So once all the results are in and if they confirm we need larger beetles to cope with our fickle spring weather, what can we do about it? Over time the beetles may well evolve a larger body size, but can we do anything to speed things up? "We have been cautious about racing to import fresh stocks of beetles because of the risk of importing the microsporidian disease that they are commonly infected with in their native range," said Paul. Instead we are working to develop a molecular technique that can reliably detect microsporidia, even at low levels. If successful this would allow us to more safely import and release some bigger beetles.

This research is funded by the Foundation for Research, Science and Technology, the Department of Conservation and the New Zealand Army.



UK beetles are significantly larger than New Zealand individuals and males are significantly larger than females.

Can Biocontrol Agents Cause Evolutionary Changes in Weeds?

When a species of plant is introduced into a new area and escapes from its natural enemies the reduced pressure from these specialist herbivores means the plant may undergo some evolutionary changes. Plants with genotypes that allocate more resources to competitive abilities and reproduction and less towards defensive measures are favoured. This explains why a species is often more prolific in its introduced range than its native range. There may also be changes in the defence compounds used, i.e. from ones effective against specialists to those that are more effective against generalists.

However, what happens when natural enemies are introduced further down the track? Does natural selection drive things back the other way? Over time would we expect the introduced weed to become increasingly similar to native populations of the plant, and less like other introduced populations that have not been exposed to biocontrol? A group of scientists in Switzerland have been trying to find answers to these questions in a study involving ragwort (*Senecio jacobaea*) and its old enemy the ragwort flea beetle (*Longitarsus jacobaeae*).

You may remember that back in 2004 we asked people to send in ragwort seeds, from areas where the ragwort flea beetle was established and areas still free of this agent, to be used in this project. Seeds were sourced from North America too where ragwort is also an introduced weed. The ragwort seeds from New Zealand and North America were planted out in Switzerland, alongside seeds collected from native populations.

"The results turned up a few surprises," reports Urs Schaffner of CABI Bioscience. The introduced ragwort populations had higher levels of chemicals used to deter generalist predators and also higher reproductive output than native populations, but there was no difference in relative growth rate and final biomass. However, the latter result may have been affected by the experimental design, which allowed strong competition from other plants growing in the plots.

Plants from New Zealand populations that had been exposed to the flea beetle were more poorly defended against generalist predators than those without the beetles. Plants from North America did not show this pattern. In New Zealand the latitude was similar for all seeds collected. However, in North America seeds were collected from a much wider latitudinal range, and the concentration of defence chemicals seems to vary with respect to latitude. In addition the flea beetles have mostly been released in the south so the seeds from populations exposed to the beetles were from a much narrower latitudinal range, which could have further confounded the results.

Also contrary to expectation, plants from introduced populations that had been exposed to the flea beetles were hit harder by resident Swiss flea beetles during the study than those without a biocontrol history.

Overall differences between introduced ragwort populations, whether exposed to the flea beetle or not, were small. Differences between native and introduced ragwort populations were larger. This may be because ragwort has been in New Zealand and North America a lot longer than the flea beetles, and it may be too soon to detect changes caused by the introduction of the beetles. In any case this study has provided little evidence that ragwort is able to undergo rapid evolutionary change once reunited with the flea beetle, and maybe this is why the latter has been such a successful biocontrol agent.

Thanks very much to those who sent in seeds for this study.

Pointed Problems with Needle Grass Project

"There's never a dull moment with the Chilean needle grass (*Nassella neesiana*) project," sighed Jane Barton when she returned from her latest trip to Argentina to assist Freda Anderson at CERZOS. This time, it wasn't a contrary fungus holding things up, but the red tape involved in getting plants needed for host-range testing into Argentina. The organisation in charge of permits, SENASA, is concerned that grasses native to Australia and New Zealand could run amok in Argentina in the same way that Argentinean *Nassella* species have become invasive here. David McLaren (Department of Primary Industries, Australia), the driving force behind the *Nassella* biocontrol project in Australia, has been trying to convince SENASA that Freda will not let the Australasian plants escape or set seed. He visited SENASA headquarters in Buenos Aires on his way to rendezvousing with Freda and Jane in Bahía Blanca. Fingers crossed that his talks will bear fruit in the form of an entry permit for the plants. Otherwise, the host-range testing may have to be moved elsewhere, perhaps South Africa.

On a more positive note, Freda has been making good progress with the potential agents. Some of the grasses on our test list are already present in Argentina, so it was possible to start testing the most promising rust (*Uromyces pencanus*). So far, the rust has behaved itself. "While spores have been observed (under the microscope) penetrating the stomata of some of the non-target plants, no rust pustules have formed, and no significant disease symptoms have developed," explained Freda.

We have mentioned previously that the strain of *U. pencanus* that Freda is working with does not seem to attack Chilean needle grass from New Zealand populations. However, we recently realised that Freda has only tested it against material from Hawke's Bay and Auckland and not Marlborough where the weed causes the most problems. With help from Mike Bell and colleagues (Marlborough District Council) we now have seed from Marlborough to send to Freda. Also, Jonathan Boow and Holly Cox (Auckland Regional Council) have provided more seed from Auckland, as the few plants Freda had from that population have died. The problem is we still need permission to get this seed into Argentina.

Meanwhile, Freda has continued her efforts to find a method to "bulk-up" the second-most-promising rust, *Puccinia graminella*. This has been difficult because when she inoculates a batch of Chilean needle grass plants with the rust, results are inconsistent; "Some plants develop lots of pustules, some develop a few, and some don't develop any at all," said a frustrated Freda. She suspects the grass population has some genetic resistance to *P. graminella*, and has just set up a student project to test that theory. If there is genetic resistance in the grass population in Argentina, we would be lucky not to find similar resistance in the weed populations in Australia and New Zealand.

So, Freda continues to have more than her quota of challenges. Fortunately, the Australian Government came through with more funding through the "Defeating the Weed Menace" programme, so she has at least another year to crack this particularly tough nut.

The Team: Jane (front, far left), David (behind Jane), Freda (middle front) and her three assistants: Paula Hansen (behind Freda), Andrea Flemmer (beside Freda) and Gabriel Roth (back, far right).

The New Zealand contribution to this project is funded by a national collective of regional councils and the Department of Conservation. Jane Barton is a contractor to Landcare Research.

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
- Boneseed leafroller monitoring form
- Broom gall mite
- Broom leaf beetle
- Broom leaf beetle monitoring form
- Broom shoot moth
- Californian thistle stem miner
- Green thistle beetle
- Ragwort crown-boring moth monitoring form
- Ragwort plume moth monitoring form

Role of Insect Rearing in Biocontrol Failure

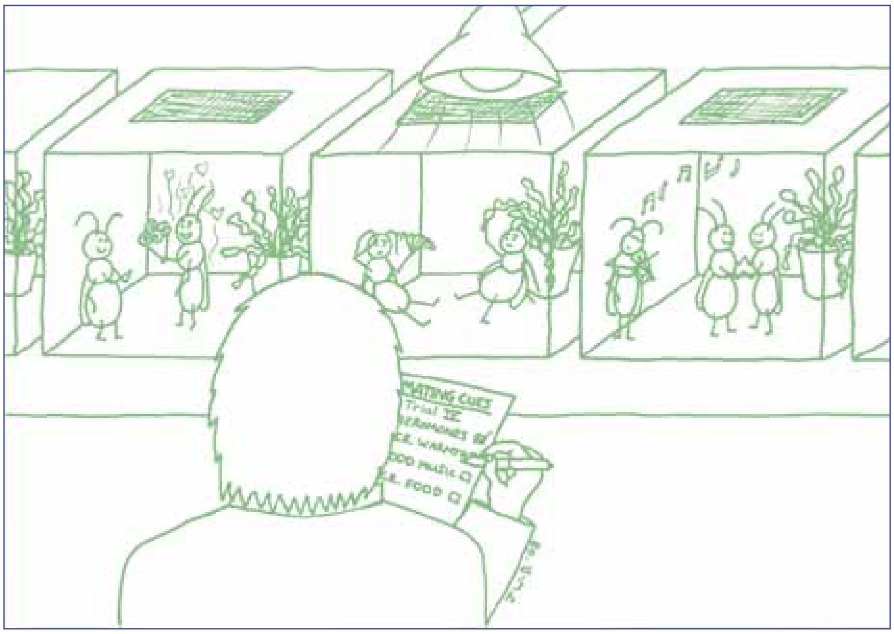
An underestimated but potential stumbling block to weed biocontrol programmes is the inability to rear a promising insect agent. Most weed biocontrollers have had some experience of this situation, including for New Zealand the hieracium plume moth (*Oxyptilus pilosellae*), hieracium hover flies (*Cheilosia* spp.), gorse hard shoot moth (*Scythris grandipennis*), and to a lesser extent old man's beard sawfly (*Monophadnus spinolae*). Problems during rearing affect the whole programme by holding up host-specificity testing, field releases, and possibly permission for release in the first place if the population cannot be reared through several generations to ensure it is free of disease and parasites.

As few published weed biocontrol studies include any mention of insect rearing problems, an international survey was conducted to determine the frequency and type of problems that programmes encounter. The survey consulted researchers from eight countries and covered programmes targeting 64 weed species. Information was collected on 384 potential arthropod biocontrol agents (including nine mite species), and the results were presented at the XII International Symposium on Biological Control of Weeds in France last year.

Confirming suspicions, the most frequently cited general problem when developing insect agents for weed biocontrol was the "inability to rear" (56% of cases). Two other common problems were "collecting sufficient specimens during exploration stage" and the "ability to establish agent in the field". These latter two could also be attributed to rearing difficulties as they may not have been significant issues if the insect had been easy to rear and therefore numbers plentiful and easy to get hold of.

Specific rearing problems were grouped into several categories. "The most common were unsuitable conditions, whether for mating, egg-laying or normal larval development," said Rosemarie De Clerck-Floate of Agriculture and Agri-Food Canada, who led the survey. The second most common group of problems relate to the lack of knowledge of the insects' life-cycle or biology. Problems with the host plant included sourcing the correct life stage or quality for the insect, and issues with incompatibility. Problems with diseases and pathogens were less commonly reported. There was a very low response to problems with "inbreeding or genetic adaptation to laboratory conditions reducing quality of colony". However, it is suspected that this is an underestimate. Responses to more specific questions showed that the majority of captive populations are not monitored well enough to pick up genetic problems.

Questions about how far the biocontrol programme had progressed when a potential agent was rejected show that, when it is due to rearing issues, most occur at the early exploration or host-specificity testing stage. "However, almost 30% of the species rejected were at the release or mass-production stage. This is significant as these insects may have incurred sizeable costs to the programme by having progressed this far," said Rosemarie.



The survey concludes that rearing issues can have a significant impact on the outcome of weed biocontrol programmes worldwide. If potential agents that may be difficult to rear could be identified early on then resources could be redirected towards identifying suitable rearing methods or spent on another species that is easier to rear. Almost a third of respondents to the survey said that certain taxonomic groups or feeding guilds were initially avoided or given lower priority because of potential rearing problems. However, it is still worth persevering with species from "difficult" groups as this will improve our rearing knowledge and capability and reduce the likelihood that potentially useful agents are rejected prematurely.

Things To Do This Autumn

Before winding down for winter there are a few things you might need to do:

- Check whether bridal creeper rust (*Puccinia myrsiphylli*) has spread to your area. Look on the underside of leaves for the distinctive yellow and black pustules. They may also be found on stems and berries. Helen Harman would like to know about any new sightings and places where the rust has not yet spread to (harmanh@landcareresearch.co.nz).
- Check for the presence of the gorse pod moth (*Cydia succedana*). The creamy-coloured caterpillars and their granular frass will be found inside pods and small entry/exit holes may also be seen in the pod wall. On calm, sunny days you may see the small brown adult moths fluttering around gorse bushes. This agent is widespread but can be redistributed by moving branches of infested pods.
- Check gorse bushes for gorse thrips (*Sericothrips staphylinus*). To avoid confusion with flower thrips (*Thrips obscuratus*) check bushes when they are not flowering. Beat branches over a piece of white card or material and if numbers are good you could shift infested material to new sites.
- Check release sites of the gall-forming agents. Early autumn is the best time to find galls caused by the mist flower gall fly (*Procecidochares alani*), hieracium gall midge (*Macrolabis pilosellae*), hieracium gall wasp (*Aulacidea subterminalis*), and Californian thistle gall fly (*Urophora cardui*). If you find good numbers you could harvest mature galls and release them at new sites. The exception, however, is the hieracium gall midge, which is best redistributed by transplanting whole infested plants in the spring.
- Harvest Scotch and nodding thistle gall flies (*Urophora stylata* and *U. solstitialis*). Signs of gall fly infestation are fluffy-looking flowerheads that feel hard and lumpy when squeezed. To redistribute, collect infested flowerheads and put them in an onion or wire mesh bag. Hang the bag on a fence at the new release site. The galls will rot down over winter and the flies will emerge in the spring.

Remember to read up the relevant pages in *The Biological Control of Weeds Book– Te Whakapau Taru* (see www.landcareresearch.co.nz/research/biocons/weeds/) before embarking on any of these activities, and let us know how you get on!

Galls on mist flower.

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Thanks to: Christine Bezar
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