What's New In Biological Control Of Weeds?

What's Inside:

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Manaaki Whenua
Landcare Research

Mighty Midget

The hieracium gall midge (*Macrolabis pilosellae*) is showing all the hallmarks of being a very promising biocontrol agent. The first ever releases of this agent were made in February 2002 at two Canterbury high country stations: Glenthorne (North of Lake Coleridge) and Balmoral (Mackenzie Country). Lindsay Smith was pretty chuffed to find galled plants at Glenthorne a year later. “Establishment is looking really promising at this early stage,” Lindsay enthused. “The midge has the potential to build up numbers relatively quickly, as it is able to complete 2–3 generations during the warmer months of the year.”

A mass-rearing programme has been underway at Lincoln during the past year to allow widespread releases to begin. Our rearing facility has been boasting some impressively damaged mouse-ear hawkweed (*Hieracium pilosella*) plants. The female midges lay their eggs in the centre of rosettes, in stolon tips, leaf axils, and sometimes in the flowerheads. The resulting larvae cause galls to form as they feed and develop. Infested plants are unmistakeable with their curled leaves and swollen deformities. The midges may be tiny (adults are <2 mm long) but they pack a lot of punch! Three species of hawkweeds are likely to be affected. As well as mouse-ear hawkweed, king devil (*H. praealtum*) and field hawkweed (*H. caespitosum*) are expected to be in the firing line too.

The midges have been released at 12 sites this season (see table over page) and most of these were made possible by funding from the Hieracium Control Trust. Because the adults are fragile and short-lived (2–13 days) the best way of releasing them seems to involve planting out infested plants. We will continue to mass-rear the midges for at least another couple of years (enquiries to Lynley Hayes, hayesl@landcareresearch.co.nz or Ph (03) 325-6701 ext 3808).

Typical gall midge damage.

Gall Midge Release Sites 2002/03
New Zealand Army x 4, Waiouru
Bluff Station, Kekerengu
Mt Gladstone, Awatere
Molesworth, Awatere
The Hossack, Hanmer Springs
Mt Pisa, Wanaka
Carrick, Bannockburn
Earnscleugh, Alexandra
Matangi, Alexandra

The other gall former released to attack hawkweeds, the gall wasp (*Aulacidea subterminalis*), has now been released widely and has established at 21 out of 52 sites so far. The gall wasp damages the stolons, preventing the formation of daughter plants at the tips. These galls are typically the size of peas and start off green but later turn brown.

Hot Gossip

In a previous issue we told you that we had been helping a **community ragwort action group on the West Coast of the South Island** to hasten the demise of ragwort (*Senecio jacobaea*) in that part of the world. We suspect that the mighty **ragwort flea beetle** (*Longitarsus jacobaeae*) has met its match and doesn't find conditions there to its liking (it's probably just too wet for them). Last year the group applied to MAF's Sustainable Farming Fund for $300,000 to be spent over 3 years, and we can happily now report that this bid has been successful. A number of organisations have pledged financial assistance to the project, which helped to ensure that it got funded. Thanks to the West Coast Regional Council, Westland Conservancy of the Department of Conservation, Westland Milk Products, West Coast Development Trust, and the West Coast Branch of Forest & Bird. The New Zealand Landcare Trust has also been heavily involved in getting the project off the ground. This new funding will allow an in-depth assessment of ragwort flea beetle establishment on the West Coast to be carried out (and is expected to confirm our suspicions that it isn't doing well anywhere there). The funding will also allow two new agents to be tested, imported and released. Colleagues in Australia who have worked with the **ragwort plume moth** (*Platyptilia isolodactyla*) and **ragwort leaf and crown-boring moth** (*Cochylis atricapitana*) have recommended that these two agents may be better able to cope with conditions on the "Wet Coast".

The **gorse pod moth** appears to have a **wider host-range than we expected**. Recent investigations have revealed that the moth is attacking pods produced by other exotic members of the Fabaceae family such as broom (*Cytisus scoparius*). This was not predicted by host-range testing so further studies are underway to try to understand why this has happened. Despite exhaustive searches **no evidence of damage to any native plants** such as prostrate kōwhai (*Sophora prostrata*) and native brooms (*Carmichaelia* spp.) has been found.

Information Sheets Available

We still have good stocks of most of the information sheets that comprise "The Biological Control of Weeds Book". If you would like a supply of any of these sheets for giving out at displays, field days, or to students doing essays etc. then please contact Lynley Hayes (hayesl@landcareresearch.co.nz, or Ph 03 3256 701 ext 3808).

Ragwort is unfortunately still a familiar sight in many places on the West Coast.

On 1 February a workshop was held at Lincoln, as part of the 8th International Congress of Plant Pathology, focussing on biological control of weeds using fungal pathogens. Over the next four pages we feature the stories shared that day of most relevance to New Zealanders.

Graeme Burdôt, AgResearch

Geoff Hurrell (AgResearch) looking after the Christchurch mycoherbicide field trial.

Field Trials and Tribulations

"Finally, we've done it!" Jane Barton told the international experts at the Christchurch workshop. "We've found a way of killing gorse plants without using chemicals! It's easy, just set up a mycoherbicide field trial in a large patch of mature gorse, tie small white plastic tags on some of the bushes, and then sit back and watch as month by month the plants die, regardless of whether or not you've applied any fungus to them!" Jokes aside, it seems that our poor plant pathologists were just unlucky enough to choose a gorse patch in Auckland that was, unbeknown to them at the time, naturally reaching the end of its life span. The presence of lots of hollow dead stems suggests that the lemon-tree borer (*Oemona hirta*) might be hastening its demise.

Fortunately all was not lost, as the experiments that Jane and Alison Gianotti set up to test fusarium blight (*Fusarium tumidum*) and silver leaf fungus (*Chondrostereum purpureum*) in Auckland were duplicated in Christchurch by Graeme Bourdôt and Geoff Hurrell, of AgResearch, and the gorse down south has been better behaved. Two trials were replicated at both sites.

The aim of the first trial was to find the best time of year to apply silver leaf fungus to gorse. The four researchers involved went out once a month for a year (beginning May 2001) and treated gorse bushes with the fungus. Because silver leaf fungus can only infect living plants through a wound, mycelium in agar was placed on top of cut stems and tied securely in place. Other stems were also cut and either given an application of just the agar or left alone completely to act as experimental controls.

The aim of the second trial was to explore whether fusarium blight and silver leaf fungus can work together in a complementary way. Silver leaf fungus is known to be most active in woody tissues, while fusarium blight is particularly damaging to young fleshy tissues, so in theory all bases would then be covered! Silver leaf fungus was applied to woody cut stems in May 2001, and then several months later when new growth was appearing fusarium blight was sprayed on in an oil-based formulation. Controls were provided, by spraying plants with the oil-based formulation minus the spores or just plain water.

During the first year of the trials the four researchers checked their handiwork monthly (looking for signs of infection and measuring regrowth) and extended this out to 3-monthly intervals during the second year. "The first year of monitoring at the Auckland site didn't show any statistically significant differences between treatments in either trial, but this was probably because so many of the control plants died – curse that lemon-tree borer!" exclaimed Jane. Fortunately, the results from Christchurch were more promising. Plants treated with either of the two silver leaf fungus isolates produced nearly two-thirds less regrowth than the control plants (Figure 1). Neither of the two silver leaf

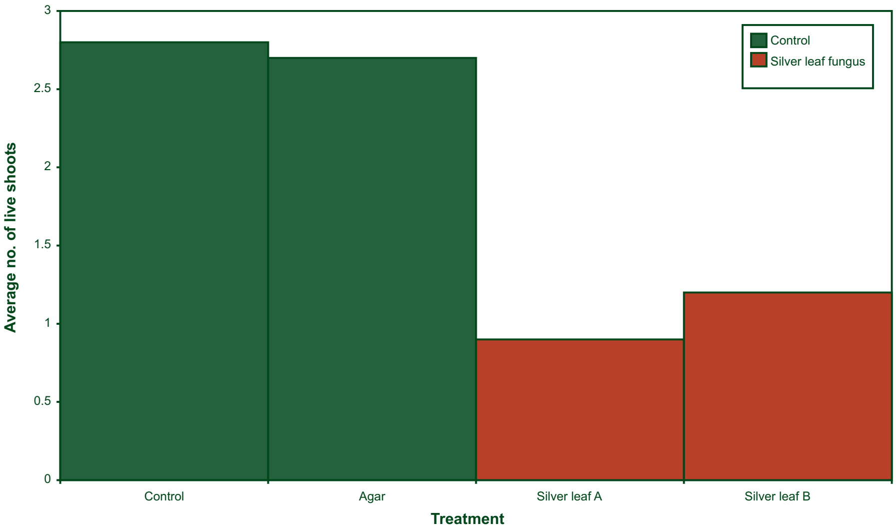


Figure 1. Trial 1, Christchurch. Gorse growth after application of silver leaf fungus isolates. Note: The red bars are statistically significantly different from the green bars ($P < 0.05$).

fungus isolates tested seemed to be superior to the other, and as expected the control treatments (agar alone or just cutting) did not affect growth significantly.

Also as expected, the impact of the silver leaf fungus varied depending on when it was applied. In Christchurch, bushes treated in May, August, September and October 2001 or February and March 2002 produced significantly fewer shoots than the controls. So the best time of year to apply the silver leaf fungus to maximise disease on gorse plants is when the weather is mild (i.e. avoid midwinter and midsummer, at least if you're in the South Island).

In the second trial plants treated with silver leaf fungus again produced less regrowth than control treatments (Table 1, column 1) and the two isolates still performed equally well. There was almost no regrowth after stems were treated with both silver leaf fungus and fusarium blight or silver leaf fungus plus the oil formulation (Table 1, columns 2 and 3). "This means that the oil formulation we used to protect the fusarium blight spores was damaging to the gorse plants in its own right," explained Jane. "This was an unfortunate result, as the toxicity of the formulation masked any impact (if there was one) of the fusarium blight and we still don't know if the two fungi work particularly well together."

"The best time of year to apply the silver leaf fungus is when the weather is mild"

The effects of the silver leaf fungus were slow to appear in both trials, with no regrowth shoots recorded as dead until at least 6 months after treatment. The infection has also remained localised, with no evidence that it has spread beyond the treated stems. Therefore, while the results show that the silver leaf fungus is capable of reducing the vigour and survival of regrowth shoots on gorse, further work is needed to determine if either of these pathogens can cause enough damage to be used as a mycoherbicide on mature gorse plants. Meanwhile, at least the lemon-tree borer at the Auckland site is doing a good job!

Table 1. Trial 2, Christchurch. Average number of live shoots on gorse stems in November 2002, after treatment with silver leaf fungus in May 2001 and fusarium blight in November 2001.

	Fusarium blight treatment		
Silver leaf treatment	Control (water only)	Formulation	Fusarium blight fungus in formulation
Control (cut only)	2.5 ab	1.0 abc	1.0 abc
Agar (cut plus agar)	3.6 a	0.5 bc	0.5 bc
Silver leaf fungus A	0.6 bc	0.2 c	0.2 c
Silver leaf fungus B	0.4 bc	0.0 c	0.0 c

Note: The letters following the numbers denote whether treatments are statistically significantly different or not ($P < 0.05$). Treatments sharing the same letter (on its own or in combination with other letters) are not significantly different from each other. Treatments with different letters (or no overlap of letters) are significantly different from each other.

Game Over for Aggressive Australian in South Africa

It's always great to hear a success story, especially when it involves beating an Australian at something! Cheryl Lennox of the Plant Protection Research Institute at Stellenbosch, South Africa, told the Christchurch workshop about a highly successful programme that has now brought an invasive Australian tree, Port Jackson willow (*Acacia saligna*), back into line. Australian wattles were introduced to South Africa to stabilise sand dunes in coastal areas. They did the job admirably well but unfortunately didn't stop there, spreading inland, particularly along river valleys, displacing native vegetation, creating a fire hazard, interfering with agriculture, and sucking rivers dry.

A biological control programme against Port Jackson willow began in the mid-1980s and permission to release a gall rust fungus (*Uromycladium tepperianum*) was granted in 1987. The fungus attacks young vegetative material such as new phyllodes (leaves) and flower buds. "It established and spread extremely well and now occurs throughout the range of the weed in South Africa," Cheryl explained. Brown galls, some as large as a fist, have become a common sight on Port Jackson trees. You may notice similar galls on Australian wattles in New Zealand as several *Uromycladium* species, including *U. tepperianum,* occur here too.

A study has been underway since 1991 to measure the impact of the gall rust. "By 2001 we estimated that on average 80% of trees at our study sites were infected and larger infected trees had around 170 galls each," revealed Cheryl. The density of the trees has been substantially reduced to around 3–55% of their former levels. Most of the older trees have been killed. Many of the remaining ones are young seedlings, which rapidly become infected by the rust. In many areas native "fynbos", grasses and sedges are beginning to replace the unwanted trees. "The gall rust has been a great success and Port Jackson willow is now completely under biological control in South Africa," Cheryl confirmed.

Lynley examining galls at Stellenbosch.

Although some seeds are still being produced, the numbers are considerably reduced and seedling survival is now poor thanks to the gall rust. Seed production is expected to decline even further with the recent introduction and release of a seed-feeding weevil (*Melantarius compactus*).

Wilding Conifers Workshop: Could Biocontrol Ever Be the Answer?

We are organising a workshop in Christchurch on Monday 11 August immediately preceding the New Zealand Plant Protection Society's annual conference. The aim of this workshop is to allow a frank and open discussion about whether biological control is a possible solution to our serious wilding conifer problem. Seed funding for this workshop is being provided by regional councils nationwide. There is likely to be an attendance charge to cover the cost of catering and a copy of the proceedings (we are hoping to capture the wealth of information presented that day in book form).

Speakers will address all angles of the conundrum from the extent of the wilding conifer problem and the problems they cause, current control operations and possible new control technologies, prospects for finding suitable biocontrol agents, and possible conflicts of interest such as the risk of biocontrol agents vectoring pine pitch canker (should it ever arrive here). Overseas experts from South Africa and the United States who are grappling with these same issues have been invited to speak at the workshop. After the presentations are completed workshop participants will be able to debate possible future options, consider whether the potential risks associated with biocontrol outweigh the possible benefits, and come up with some recommendations about what should happen next.

If you are interested in attending this workshop or purchasing a copy of the proceedings please contact the convenor Richard Hill (hillr@crop.cri.nz, or Ph 03 3256 400).

A Virus Worth Sharing?

Those of you with memories like elephants may recall that when we looked into the prospects for biological control of moth plant (*Araujia sericifera*) we mentioned that the araujia mosaic virus (AjMV) commonly stunts the plant in Argentina. This virus is transmitted from plant to plant by aphids and one of these (*Aphis nerii*) is already present in New Zealand. However, we cautioned that viruses had rarely been contemplated as biocontrol agents for weeds and we therefore had reservations about the feasibility of this approach. At the Christchurch workshop Professor Raghavan Charudattan (or Charu to his friends) from the University of Florida, USA, told us about a promising project to control tropical soda apple (*Solanum viarum*) using a virus, the tobacco mild green mosaic tobamovirus (TMGMV). Tropical soda apple is a nasty thorny invasive weed of South American origin that is still spreading at an alarming rate. Luckily we don't have it here.

" There are no storage or shelf-life problems "

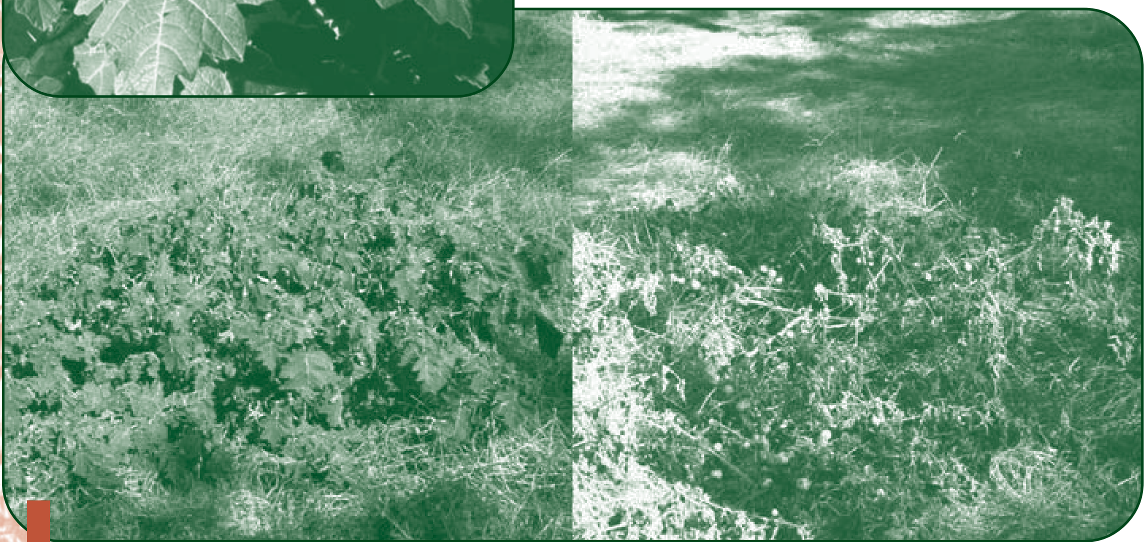
TMGMV kills tropical soda apple fast (10–21 days in glasshouse trials). "Plants of all ages are susceptible with older plants taking longer to succumb," explained Charu. Good results in the glasshouse don't always carry over to the field, but trials at three different locations in Florida resulted in an 83–97% kill rate. Researchers have been experimenting with various application techniques and a high-pressure spray seems to be effective. "The vicious spines on the plant allow it to inoculate itself," revealed Charu. The natural mode of spread is not understood but TMGMV is thought to be a contact virus and not one vectored by insects.

A brew of TMGMV can easily be prepared by propagating the virus on susceptible Turkish tobacco (*Nicotiana tabacum* var. Turkish Samsum) and extracting the inoculum, which is then stored as leaf extract at -20°C. "There are no storage or shelf-life problems," marvelled Charu. Furthermore, TMGMV is not harmful to humans and can easily be deactivated with laundry detergent.

The only downside is that TMGMV has a wide host-range. It primarily affects members of the Solanaceae and could harm desirable vegetables like peppers (*Capsicum annuum*). However, TMGMV occurs naturally in Florida and many parts of the world so it may be acceptable to apply it in areas well away from any susceptible beneficial plants. More research into the risks, such as how long the virus persists in the soil, needs to be carried out before researchers can be sure that the virus is the answer to the state's tropical soda apple problem.

Back in New Zealand we are currently undertaking a study to see what organisms attack moth plant here. If funding can be found to investigate prospective control agents overseas, on further advice from our American colleagues, we may just take another look at the AjMV.

Raghavan Charudattan



Tropical soda apple "the plant from hell" before and after a dose of Tobacco mild green mosaic tobamovirus.

The Good, the Bad, and the Ugly

Former staff member Louise Morin (now at CSIRO, Canberra) summarised for the participants at the Christchurch workshop the risks and benefits of introducing exotic pathogens to control weeds. Since the 1970s the popularity of using pathogens (primarily rust fungi) has been on the up and up. In fact it is only in the last decade that Landcare Research has employed plant pathologists to work on biocontrol of weeds. As always there are risks of undesirable non-target effects. So what are the risks?

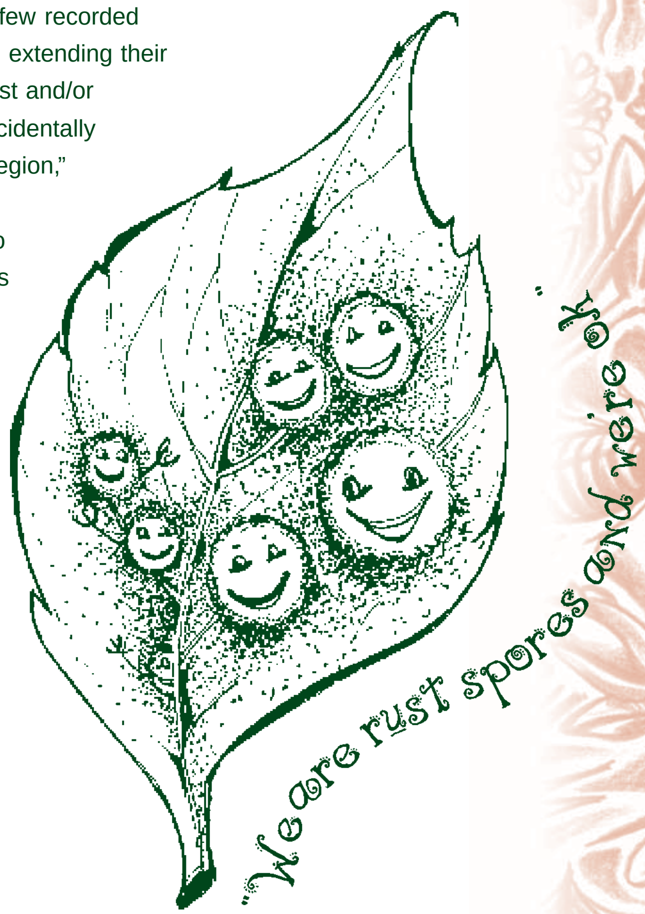
There is always a concern that the pathogen might attack other desirable plants. Safety testing is carried out according to internationally accepted guidelines, which are continually being revised and refined in light of new information. "The determination of the likely host-range of a pathogen is not an easy process particularly when symptoms of infection may take as long as 18 months to show up, as was the case with the bone-seed rust (*Endophyllum osteospermi*)," explained Louise However, we can take heart from the fact that the testing procedures do appear to be satisfactory, since the safety record for using pathogens remains unblemished.

There is a possibility that if a weed is successfully controlled it may simply open up a niche for other undesirable plants to fill. If a weed is only partially controlled, because not all biotypes are susceptible, then there is a danger of simply replacing susceptible biotypes with resistant ones. In Australia a narrow-leaved form of skeleton weed (*Chondrilla juncea*) was spectacularly controlled using a rust, *Puccinia chondrillina*, but the party was short-lived as resistant broad- and intermediate-leaved forms stepped into the breach. However, as Louise points out, "these scenarios can be avoided by careful planning and by combining and integrating land management and weed control techniques."

"The safety record for using pathogens remains unblemished"

All living organisms have the power to evolve and adapt to a changing environment or exploit a new niche. However, the risk of exotic pathogens changing and evolving over time is no different to the risk of endemic pathogens doing the same thing. "Worldwide there are few recorded instances of rust fungi extending their host range when a host and/or fungus have been accidentally introduced to a new region," revealed Louise. Hybridisation can also occur but rarely results in strong viable offspring. There is also a risk of weeds evolving and becoming resistant to biocontrol agents, but they could in turn adapt and find new ways around the problem leading to a co-evolutionary arms race.

There have been some highly spectacular successes controlling weeds using pathogens, e.g. mist flower (*Ageratina riparia*) in Hawai'i and now New Zealand, and Port Jackson willow (*Acacia saligna*) in South Africa (see *Game Over for Aggressive Australian*, page 5). The collective gain of such programmes has generally far exceeded any implementation costs. Rust fungi do not generally require redistribution, as they are effectively dispersed by the wind and the benefits they bring are freely available to all. The general consensus seems to be that the benefits of controlling weeds using introduced pathogens (and insects) far outweighs the risks. "However, it is important to be realistic about the risks of biocontrol and remain vigilant at all times."



Things To Do This Winter

Winter is the time when you can take a bit of a breather because most biological control agents are not very active or visible at this time of the year. However, you can still:

- Check nodding thistle crown weevil (*Trichosirocalus mortadelo* formerly *horridus*) release sites. Some weevils lay eggs all year round, but the bulk of them begin to lay in the autumn and the damage to the rosettes becomes more noticeable as the winter progresses. As the grubs feed in the crown they produce a black waste substance (frass), and the ribs of the surrounding leaves take on a reddish-brown colour at the base. The leaves of damaged rosettes become less prickly and start to look a bit like dandelion leaves. You may see rosettes that look like this at any time of the year, but the damage is usually most obvious later in the winter and in early spring. If you dig a damaged rosette out of the ground and cut it in half with a pocket-knife, you should be able to see the white grubs feeding inside. As well as nodding thistles (*Carduus nutans*) the weevil also attacks cotton (*Onopordum acanthium*), marsh (*Cirsium palustre*), plumeless (*Carduus acanthoides*), Scotch (*Cirsium vulgare*), slender-winged (*Carduus pycnocephalus*) and winged (*Carduus tenuiflorus*) thistles, so look out for damage to these plants too. Crown weevils can often be harvested and shifted around as late as June.
- Make plans for the coming spring, e.g. start thinking about suitable release sites for any new agents that you may be receiving from us next season, and plan harvesting operations and field days.
- Get up to date on the paperwork!

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