WHAT'S NEW IN

Biological Control of Weeds?

Issue 51 February 10

Blackberry Rust

What's Inside?

Landcare Research
Manaaki Whenua

Chilean Needle Grass Biocontrol Breakthrough

When we are searching for biocontrol agents we look for highly host specific natural enemies that will not attack other desirable plants, but sometimes, especially in the case of plant pathogens, we come across a species that has a host range that is too narrow. This has turned out to be the case with the most promising natural enemy of Chilean needle grass (*Nassella neesiana*). None of the isolates of the rust fungus *Uromyces pencanus* that have been found and tested to date are able to infect all the populations of Chilean needle grass sourced from New Zealand and Australia (which has a much more widespread and severe problem with this weed than us).

Until recently, only Chilean needle grass from New Zealand's North Island (Auckland and Hawke's Bay) had been tested against *Uromyces pencanus*, and it was found to be resistant to the rust. Seed from Marlborough populations of the weed was only able to be shipped to Argentina last February for testing. "Fortunately two isolates have now been identified which can infect Chilean needle grass from Marlborough," reports Jane Barton, who has travelled several times to Argentina to assist with this project. This is an important breakthrough as the largest and most serious infestations of this grass in New Zealand currently occur in Marlborough. Also an infestation of Chilean needle grass found near Cheviot in 2008 is likely to have originated from this area and therefore be susceptible too. Observations in the lab and in the field in Argentina show that this rust is capable of severely debilitating Chilean needle grass. "The rust robs the host plant of nutrients and water, and also damages the leaf epidermis with its fruiting structures. Heavily infected leaves dry out and die prematurely in hot and dry weather, and plants with high levels of infection also produce less seed than healthy ones," explained Jane. This offers some hope in what has largely been a losing battle to date on both sides of the Tasman.

Freda Anderson (CERZOS-UNS) found the rust and has undertaken all the host-testing in Argentina. When a potential agent cannot even attack all populations of its host plant then the chances of it being able to attack other species are extremely unlikely. Sure enough, not a single spore has formed on the 43 non-target grasses (including oats, barley, rye grass, wheat, rice, bamboo and sweet corn) that Freda has inoculated. Even the closely related weed nassella tussock (*Nassella trichotoma*) is not attacked. So we can be confident that the rust is safe to release in New Zealand, and plans are afoot to prepare and submit an ERMA application

Chilean needle grass infected with *Uromyces pencanus*.

this year. If the rust is approved for release it will be the first time a biocontrol agent has been used against a grass anywhere.

One more isolate of the rust that has not yet been tested is currently being held in storage, due to space and other resource constraints. Freda will test this isolate in 2010 and "fingers crossed" that it will be able to infect North Island Chilean needle grass populations. If not there is still hope as it is unlikely that all available isolates of the rust have been collected to date and additional isolates could still be sought if funding to support this work could be found.

The New Zealand contribution to this project is funded by the National Biocontrol Collective. Jane Barton is a contractor to Landcare Research.

CONTACT: Lynley Hayes (hayesl@landcareresearch.co.nz) or Jane Barton (jane.barton@ihug.co.nz)

Can Blackberry Rust Be Made More Potent?

Blackberry (*Rubus fruticosus* agg.) is a prickly problem in both Australia and New Zealand. The "agg." (= aggregate) in its Latin name indicates that it is not a single species. There are 22 naturalised species and hybrids in New Zealand, and a similar number in Australia. This makes it a difficult target for biocontrol, but that hasn't stopped us trying! Blackberry rust (*Phragmidium violaceum*) has been introduced as a biocontrol agent to Australia. It was first released there, illegally, in 1984 and it subsequently arrived in New Zealand (presumably via wind-borne spores) in 1990. Then, in 1991, an officially sanctioned rust strain (F15) originating from France was also released in Australia.

While blackberry rust spread well in both countries, the damage it caused was variable and at least some of this inconsistency appeared related to the variability of the host. Therefore, Australian researchers went looking for more strains of the rust. They had two aims: to increase the range of *Rubus* species attacked, and to increase the chances that the rust could evolve increased fitness and tolerance to the Australian climate. Evolution works through "survival of the fittest", and is limited by the pool of individuals it has to choose from; the higher the genetic diversity of a population, the bigger the "pool". The researchers reasoned that if they could introduce more strains of blackberry rust then they would increase the number of genes (and characteristics) that evolution could work with. By planting many genotypes of Australian blackberry plants in a "trap garden" in France they were able to collect many additional rust strains, eight of which were eventually released in Australia.

More than 400 releases of these additional strains, plus F15 in some instances, were made in Australia between spring 2006 and autumn 2009, mostly by non-scientists. More than half of these people have provided feedback, with over 95% reporting rust symptoms on blackberry soon after release.

Blackberry rust reproduces "sexually". We will spare you the details; enough to say the genes from different strains get mixed together every spring. Molecular tools were developed in Australia to monitor the establishment and persistence of the additional rust strains released. These tools confirmed that after 2 years some of the DNA from the additional strains was persisting in the rust population at some release sites.

No one expects the introduction of the eight additional rust strains to overwhelm blackberry overnight. The expected outcome is a gradual integration of the DNA (and characteristics) from the additional strains into the existing rust population, and for that to result in a gradual increase in the effectiveness of the biocontrol agent. So what are the implications for us here in New Zealand? Rust spores blow across the Tasman fairly regularly, and as the blackberry rust population in Australia becomes more genetically diverse, it is likely that ours will too. "This will be a very slow process, so it might be worth exploring deliberate introduction of some or all of the eight additional strains," said Jane Barton.

While it is hoped that greater genetic diversity will lead to a greater range of weedy *Rubus* species being attacked, it is quite possible that it will also lead to higher levels of attack on New Zealand's native *Rubus* species - which has only been observed once to date. Berry crops are not thought to be at risk. Please keep your eyes open and let us know if you see heightened levels of blackberry rust on exotic or native *Rubus* species.

Thanks to Louise Morin, CSIRO Entomology, for providing information and the photograph for this story. A documentary "Landline" is available at http://www.abc.net.au/landline/content/2006/s2195486.htm). For information on distinguishing P. violaceum *from other rusts see "*Blackberry to come under additional strain*" in Issue 44. Jane Barton is a contractor to Landcare Research.*

CONTACT: Lynley Hayes (hayesl@landcareresearch.co.nz) or Jane Barton (jane.barton@ihug.co.nz)

Blackberry leaves infected by blackberry rust.

Overcoming the Assessment Dilemma

Worldwide, detailed assessments of the outcomes of pest control operations, including the use of biocontrol agents for weeds, tend to be the exception rather than the rule. Everyone agrees that impact assessment studies are of great importance and should be done routinely, but finding the resources to undertake them has been the major sticking point. Impact assessment studies don't come cheaply and can be hard to justify when you have to choose between evaluating a completed project or beginning an urgently needed new one, especially if the success or otherwise of the completed project appears to be blindingly obvious. In a previous newsletter article (see *How successful will they be?*, Issue 35) we concluded that, as well as continuing to try to persuade funders to support the assessment phase of projects, scientists needed to find quicker and smarter ways of doing assessment. Last year, in response to renewed interest from end-users, we had a serious think about what some of those quicker and smarter ways might be, especially projects that non-scientists could undertake. We presented our ideas at a 2-day workshop in September which was attended by 13 regional council staff.

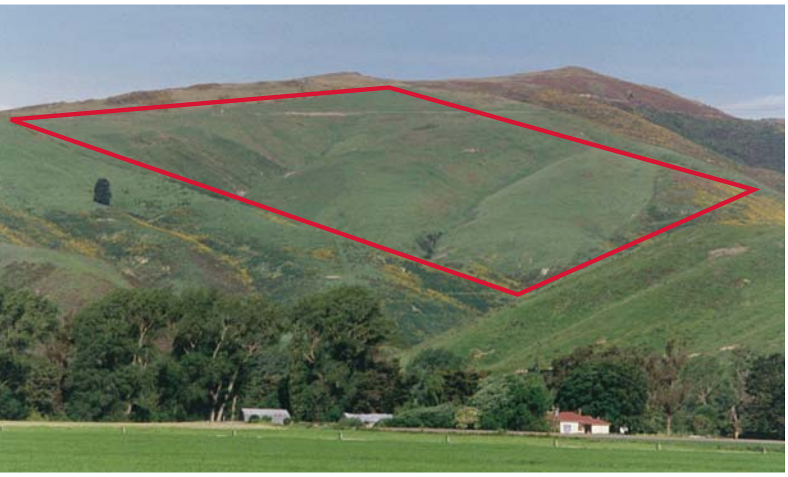
We have acknowledged that we need to set our sights a bit lower than in the past. "While detailed population and ecosystem-level studies represent the ultimate goal (especially for scientists), in reality it is never going to be feasible to undertake many of these," concluded Simon Fowler. Such high level studies will always be time-consuming, expensive and technically challenging, and will realistically need to be reserved for a few flagship projects. "However, simpler, more affordable approaches to assessment if done well and repeated across the country should be able to satisfy the needs of many organisations involved in biocontrol," suggested Simon. All assessment projects need to be very carefully thought through so money is not wasted on collecting unusable data or doing more than necessary.

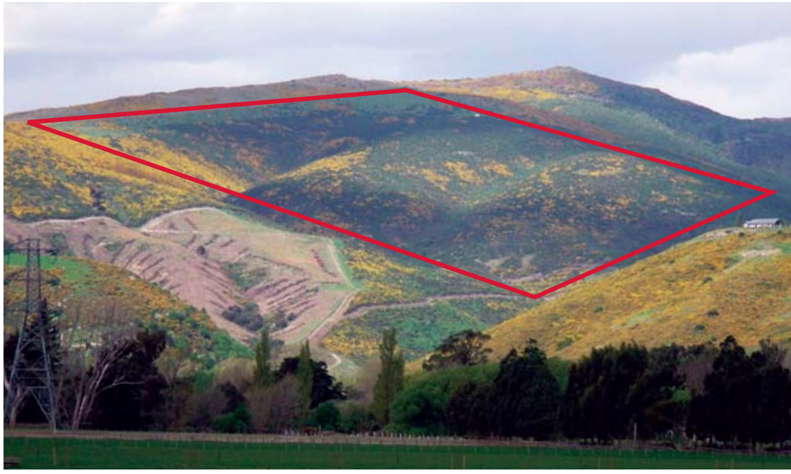
We have proposed a hierarchical approach to assessment that starts simply and becomes increasingly more complex and expensive. How far people proceed through the sequence of steps depends on the results achieved, resources available and level of proof required. The first step, which should be undertaken for all biocontrol agents, is to check if they have established or not, and it may take many years to be sure about this. While some agents like the green thistle beetle (*Cassida rubiginosa*) can often be found after only 1 year, others like the gorse colonial hard shoot moth (*Pempelia genistella*) may take 5 years to become noticeable. People checking sites also need to be confident about what they are looking for and doing it at the right time of the year – so activities like our annual training workshops, that give people these skills, will continue to be important.

If an agent has clearly failed to establish then no further assessment needs to be undertaken. Some agents establish but remain rare and hard to find, and all that can be done is to keep a watching brief, for possibly as long as 10 years, to see if they become more common. Only once agents are easy to find is it appropriate to take the next step and, depending on the species in question, measure the abundance of the agent or the amount of damage it is causing. With an agent like the broom seed beetle (*Bruchidius villosus*) it is easy to beat broom plants and count the number of beetles dislodged, but with an agent like the tradescantia leaf beetle (*Neolema ogloblini*), that would be difficult to extract from its host plant (*Tradescantia fluminensis*) and count accurately, it is more appropriate to estimate the amount of damage the beetle is causing, e.g. 50% of leaves destroyed.

If the agent is not found in good numbers (for most this will mean hundreds or thousands counted with relatively little effort) or the amount of damage is insignificant, again no further assessment effort is warranted other than keeping a watching brief to see if the situation changes. If an agent continues to fail to live up to expectations then researchers may need to undertake studies to find out why. However, if the agent is abundant and/or the damage it is causing is significant then we can now look at what this means for the weed population. This is the point at which the wheels have tended to come off in the past. The need for replication (collecting data from many sites and over many years) and randomisation (avoiding bias), especially if making detailed measurements and/or manipulating plots, provides much scope for things to go wrong, or a level of resourcing that is simply out of reach. Luckily the digital era is now offering some new options.

Photos are quick, easy to take and cheap, and have always been a good way of visually demonstrating changes in weed populations in association with harder data. However, software is now available that allows us to go a step further and analyse differences between photos, such as a change in gorse cover over time (see photos). "You simply define an area on an image, decide on measurement codes (e.g. "g" for gorse and "o" for other), then the programme provides random points for you to code," explained Paul Peterson.





Woody weed infestation on the Port Hills, Christchurch, in 1988 and 2009. Software was used to analyse the percentage cover inside the red outline and showed it had changed from 12% (gorse) to 88% (gorse and broom) during this time.

The data is then imported into Excel for analysis. The software produces one raw data file (your codings) and one summary file so that you can quickly calculate percentage cover. Sampling 200 points in a single photo only takes 5 minutes, once you get the hang of it – the more points you sample, the more accurate your estimate will be. "This technique has shown that what we thought were fairly stable woody weed infestations on the Port Hills have actually changed enormously over the past 20 years," commented Richard Hill.

Photos have some limitations. "You need to be able to see all the individual plants in your photo to sample them, so you either need to get some elevation (e.g. camera up a pole) or photograph plants on steep slopes," cautioned Paul. Photos also need to be clear enough that you can correctly identify species (e.g. tell the difference between gorse and broom growing together), that is, not too far away, out of focus, dark or blurry etc. Photos do not prove what caused a change in a weed population, so at the very least, it will be necessary to demonstrate that biocontrol agents were present in good numbers at the time of the "after" shots. You will also need to photograph a number of sites as some inevitably get lost over time to development, change in land-use, etc.

Some species do not lend themselves to photography at all, e.g. some pasture weeds (which are too variable from year to year because of the effects of land management) and many vines (when growing up too high or on something indistinguishable). For these species there may still be simpler alternatives to traditional plots, transects and quadrats, especially if some kind of "before" data are available. For example if an organisation has recorded known bridal creeper (*Asparagus asparagoides*) sites and ranked them in some way (e.g. severe, moderate or minor) before the bridal creeper rust (*Puccinia myrsiphylli*) became well established here, it could revisit these sites now and analyse statistically whether these rankings have changed, using a sign test (a very simple statistical test).

In the case of ragwort (*Jacobaea vulgaris* = *Senecio jacobaea*) and nodding thistle (*Carduus nutans*) there are hundreds of release sites nationwide that could be resurveyed. Release sites were chosen because they had severe infestations of the weed (5–10 plants/m^2). If we could get data nationwide now from these release sites, 15–25 years on, we should be able to demonstrate an overall major reduction (perhaps <1 plant/m^2, based on anecdotal reports). A survey of landowners to canvas their satisfaction and cost savings could provide additional useful insights. We are hoping to undertake a pilot study using this approach this autumn before we roll it out nationwide. The power of this approach is the sheer number and variety of sites that the data can be quickly and easily collected from. While simple data like these will always have their limitations it has to be a whole lot better than having no data at all!

The funding to prepare and present the workshop was provided by two Envirolink Medium Advice Grants (MLDC40 and TSDC56). Improved monitoring is an aim of our Beating Weeds Programme (FRST C09X0905). For enquiries about the software for analysing photos contact Paul Peterson. Richard Hill is a contractor to Landcare Research.

CONTACT: Paul Peterson (petersonp@landcareresearch.co.nz) or Simon Fowler (fowlers@landcareresearch.co.nz)

Things To Do This Autumn

Before settling down for a break over winter there are a few things you might want to do:

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

- Check release sites for the feeding shelters made by caterpillars webbing leaves together at stem tips. Caterpillars are olive-green when small and become darker with rows of white spots as they get older. Do not harvest caterpillars until spring.

Gorse pod moth (*Cydia succedana*)

- Check pods for the creamy-coloured caterpillars and/or their frass. Small entry/exit holes may also be seen in the pod wall. This agent is widespread but can be redistributed by moving branches of infested pods.

Hieracium gall wasp (*Aulacidea subterminalis*) and gall midge (*Macrolabis pilosellae*)

- Early autumn is a good time to check hieracium gall midge and gall wasp sites. Check for hieracium plants that have galls on the ends of the stolons and/or swollen and deformed leaves. If you find good numbers, you could harvest mature gall wasp galls from the end of stolons for release at new sites. Hieracium gall midge is best redistributed by transplanting whole infested plants in the spring.

Stolon galled by hieracium gall wasp.

Mist flower gall fly (*Procecidochares alani*)

- Check release sites and surrounding areas for plants with swollen deformities. Mature galls can be harvested for release in areas where the fly is not present. Make sure you collect galls that do not have windows in them as this shows that the new adults have already emerged.

Nodding and Scotch thistle gall flies (*Urophora solstitialis* and *U. stylata*)

- Check release sites for fluffy-looking flowerheads, which 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. Over winter the galls will rot down and the flies will emerge in the spring.

Send any reports of interesting, new or unusual sightings to:
CONTACT: Lynley Hayes (hayesl@landcareresearch.co.nz)

Weedy Workshops

If there is sufficient interest we will hold an advanced biocontrol workshop at Auckland in April. The aim of this workshop is to give people the skills and confidence to manage their own biocontrol programmes. This workshop is suitable for people who have a reasonable knowledge of weed biocontrol and who, ideally, attended our basic training workshop two or more years ago. We build on existing knowledge and bring people up to speed with new developments. If your organisation contributes to, or supports, our research in some way then there is no charge for this course. If not you may still be able to attend, if there are places available, for a small fee. If you are interested in attending this workshop please contact Lynley Hayes.

We are also aiming to hold a one-day workshop at Lincoln in June to share the latest weeds research findings. This is no charge to attend this workshop. If you would like to be sent further information about the date, venue and programme, please contact Lynley Hayes.

CONTACT:
Lynley Hayes (hayesl@landcareresearch.co.nz)

Damage caused to boneseed at Mangawhai by *Stemphylium lycopersici.*

Damaging Boneseed Disease Discovered

In November 2008 members of the Auckland/Northland Branch of the New Zealand Biosecurity Institute visited a boneseed leafroller (*Tortrix* s.l. sp. "chrysanthemoides") release site at Mangawhai, Northland, and discovered some severely damaged boneseed (*Chysanthemoides monilifera monilifera*). A fungal disease causing tip dieback, rather than the leafrollers, appeared to be responsible for the damage, so our pathologist Sarah Dodd collected some samples and took them back to the lab to identify the causative agent. After isolating the fungus *Stemphylium* from the samples, a single gene region was sequenced and from this we determined it was closely related to *S. solani*.

During 2009 Jenny Dymock, a contractor to Northland Regional Council, noticed that the disease had become quite widespread. Jenny had been intending to collect boneseed leafrollers from Mangawhai to release elsewhere in Northland, but was rightly concerned about spreading a disease that had not been fully identified so she contacted MAF. *S. solani* is an unwanted organism that we are trying to keep out of New Zealand as it damages economically important plants like tomatoes, peppers and garlic, so MAF was keen to confirm the identity of the fungus. Jenny sent them samples of diseased foliage from Mangawhai, Baylys Beach and Cable Bay (in the Far North). Sarah also provided MAF with the culture she had isolated.

MAF sequenced a second gene region, which pinpointed the fungus down to *S. lycopersici*, a widespread species in New Zealand. This is good news because there are strict regulations on not distributing unwanted organisms and had the fungus been *S. solani* the leafrollers could not have been moved from this site because of the risk of also shifting plant material infected with the disease. Although *S. lycopersici* has been known in New Zealand since the 1970s, no sign of this fungus was found on boneseed when we did our New Zealand survey in 1999/2000 before starting a biocontrol programme for this target. Mangawhai Heads and Baylys Beach were visited during this survey, as was Mangonui which is near Cable Bay. "Sometimes these diseases are out there just waiting for the right conditions to get going," explained Sarah.

The fungus appears to be killing boneseed plants at Mangawhai, but there are several things to consider before we decide whether or not to try to utilise this disease. The fungus is having most impact on boneseed at Mangawhai where the leafroller is also present. "I suspect that there may be some sort of combined effect going on – it could be that plants which have been weakened by leafroller feeding are more susceptible to the fungus," said Jenny. If this is the case the fungus may not be as damaging in areas without the leafroller. Also, while not an unwanted organism, *S. lycopersici* is a pest and has been recorded on several crop plants, including tomatoes and celery, and the native shore spurge (*Euphorbia glauca*). Spreading it around more widely might increase the frequency of attack on these species. "*S. lycopersici* could potentially be a candidate for bioherbicide development, but we would need to do more work before we went down that track," said Sarah. One way or another it is likely that the fungus will become more common on boneseed with time anyway, and we would be interested to hear if you see some unusually sick looking boneseed in other parts of the country.

Meanwhile we are continuing with research to see if a specialist boneseed pathogen would be suitable to release here. Test plants have been exposed to the boneseed rust (*Endophyllum osteospermi*) in South Africa and we are waiting for up to 3 years to see if they become infected.

CONTACT: Sarah Dodd (dodds@landcareresearch.co.nz)

Enhancing Biocontrol in the Pacific

A workshop held in Auckland last November found great potential for a more collaborative approach to biocontrol of invasive species in the Pacific. The Pacific Biocontrol Strategy Workshop was attended by 47 people, representing 17 countries and territories (American Samoa, Australia, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, Guam, Hawai'i, New Caledonia, New Zealand, Palau, Papua New Guinea, Samoa, Tonga and Vanuatu, United States, and the United Kingdom). Four organisations representing the Pacific Region also participated: Pacific Invasives Learning Network (PILN), Secretariat of the Pacific Community (SPC), Pacific Invasives Initiative (PII), and University of the South Pacific (USP).

Biocontrol programmes that have been undertaken or are presently operating in the Pacific were reviewed. There were numerous examples where biocontrol has proven to be a highly successful and relatively inexpensive control tool. Weeds such as chromolaena (*Chromolaena odorata*), ivy gourd (*Coccinia grandis*), salvinia (*Salvinia molesta*), and water hyacinth (*Eichhornia crassipes*) have been well controlled, as have insect pests like the coconut scale (*Aspidiotus destructor*), cycad scale (*Aulacaspis yasumatsui*), papaya mealybug (*Paracoccus marginatus*) and rhinoceros beetle (*Oryctes rhinoceros*), to name but a few. "Many of the success stories are not widely known and deserve more publicity," said Lynley Hayes, who helped organise the workshop.

The workshop identified obstacles to biocontrol in the Pacific, including where essential capacity is lacking, plus opportunities for increasing the use of biocontrol. Many highly effective agents are available right now which could be shared much more widely at little cost. Biocontrol also needs to be developed for many more species. Participants discussed how to select and prioritise potential biocontrol targets and prepared lists of arthropods and weeds for further consideration. Some key new projects were identified (e.g. African tulip tree (*Spathodea campanulata*), fruit flies (*Bactrocera* spp.) and fruit-piercing moth (*Eudocima phallonia*), amongst others) that will be submitted to funders within a year.

Ways of increasing the understanding and acceptance of biocontrol in the Pacific were considered. For example an independent advisory group could be set up that can provide advice to governments. Initiatives could also be undertaken to increase communication both within the biocontrol community and externally with all stakeholders.

Workshop participants.

Finally an action plan was developed and a steering group chosen to oversee it. Steering group members include: the chairman Warea Orapa (SPC), Mark Bonin (PILN), Alan Tye (Secretariat of the Pacific Regional Environment Programme), Souad Boudjelas (PII), Wilco Liebregts (PestNet), Christian Mille (French territories), Billy Enosa (Polynesia), Tony-George Gunua (Melanesia), Konrad Engelberger (Micronesia), Quentin Paynter (NZ), Dick Shaw (CABI), Tracy Johnson (USA/Hawai'i), Darcy Oishi (Hawai'i), and Mic Julien (Australia).

"It is good to know that biocontrol can work well in the Pacific and that there is a willingness to work together to make more projects possible," concluded Lynley. "It is clear that biocontrol is likely to be the only feasible way of dealing with many Pacific pests."

The workshop was made possible due to support from the Critical Ecosystem Partnership Fund, Hawai'i Invasive Species Council, Landcare Research, NZAID, PII, PILN, SPC, SPREP, USDA Forest Service, and the United States State Department.
Workshop presentations can be seen at www.issg.org/cii/BioControlWorkshop.html

CONTACT:
Lynley Hayes (hayesl@landcareresearch.co.nz)

www.landcareresearch.co.nz

Editors: Julia Wilson-Davey, Lynley Hayes
Any enquiries to Julia Wilson-Davey

Contributions: Jane Barton
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Design: Anouk Wanrooy

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