Promising new biological control agents for Queensland

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Summary A range of promising new biological control agents are being assessed and released in Queensland: (1) five different biotypes of the cochineal insect, *Dactylopius tomentosus* (Lamark), are being field-released on several cactus species (*Cylindropuntia* spp.). One biotype is achieving excellent results, killing coral cactus (*Cylindropuntia fulgida* (Engelm.) F.M. Knuth var. *mamillata* (Engelm.) Backeb.) around Longreach (central Queensland) and Hebel (south-western Queensland). This is an exciting development for a weed species that represents a serious long-term threat to pasture production across vast areas of arid and semi-arid rangelands; (2) the gall-fly, *Cecidochares connexa* (Macquart), has achieved excellent control of chromolaena (*Chromolaena odorata* (L.) R.M. King & H. Robinson) in Papua New Guinea. Testing for specificity has been completed and an application seeking field release in Australia was submitted to the Australian Government in 2015; (3) host-specificity testing has been completed for the fungal pathogen, *Puccinia spegazzinii* de Toni, for the control of *Mikania micrantha* Kunth, a major weed of wet tropical areas overseas and a target of eradication in Australia; (4) biology studies on a root-feeding beetle for mother-of-millions (*Kalanchoe delagoense* Eckl. & Zeyh), a widespread, toxic weed of pastures are currently being undertaken prior to host-specificity testing; and (5) research has commenced to find potential agents for giant rat's tail grasses (*Sporobolus* spp.). Recent prospecting in South Africa has identified several species of stem-boring insects that are now being assessed for possible release in Australia. A new project based in Vanuatu and funded by the New Zealand Government will enable exploration in South America and south-east Asia for biological control agents targeting *Solanum torvum* Sw. (devil's fig) and *Senna tora* (L.) Roxb. (sicklepod).

Keywords Biological weed control, invasive plants, *Chromolaena odorata*, *Cylindropuntia* spp., *Kalanchoe delagoense, Mikania micrantha*, *Sporobolus* spp.

INTRODUCTION

Weeds continually cause severe impacts to agricultural and natural ecosystems across Australia. In some cases, conventional control is not feasible and biological control is viewed as the only long-term, sustainable solution to their management. The approach is also cost effective, having an average benefit:cost ratio of 23:1 (across all projects) (Page and Lacey 2006). Using quarantine facilities at the Ecosciences Precinct at Dutton Park, Brisbane, one of only four such facilities in Australia, the Department of Agriculture and Fisheries has the capacity to undertake a number of projects researching imported biological control agents. A range of promising new biological control agents are being assessed for several invasive plant species, as follows: (1) the augmentation of biotypes of *Dactylopius tomentosus* (Lamark) available for the biological control for *Cylindropuntia* spp., which are serious emerging threats to arid and semi-arid rangelands; (2) *Chromolaena odorata* (L.) R.M. King & H. Robinson, considered one of the world's worst weeds, and a serious threat to agriculture and natural ecosystems; (3) *Mikania micrantha* Kunth, a target of a nationally cost-shared eradication program, is a vine that poses a long-term threat to a range of tropical tree crops and native plant communities in the World Heritage listed Wet Tropics of far north Queensland; (4) *Kalanchoe delagoense* Eckl. & Zeyh, a major weed in Queensland and northern New South Wales, found in a range of drier, sub-coastal habitats and toxic to cattle; (5) *Sporobolus* spp., aggressive and quick-spreading grass weeds of pastures; (6) *Solanum torvum* Sw. (devil's fig), an environmental and pasture weed and (7) *Senna tora* (L.) Roxb. (sicklepod), an agricultural weed (both invading Vanuatu). While the host range of biological control agents has already been tested and approved for release overseas for several of these species, further host-specificity testing is required in Australia to meet strict risk assessment criteria as set out by the Australian Department of Agriculture and Water Resources (DAWR) and Department of Environment and Energy (DoEE). The use of insects already tested overseas saves time and money as no exploration is required and testing elsewhere tends to provide data to support the probability of a positive

outcome regarding host-specificity under Australian conditions. This paper outlines progress to date.

RESULTS AND DISCUSSION

***Cylindropuntia* spp.** Several different biotypes of *D. tomentosus* were tested in the quarantine facility at the Ecosciences Precinct (Dutton Park, Brisbane) for their efficacy in providing control of various *Cylindropuntia* spp. The 'cholla' biotype of *D. tomentosus* was imported from South Africa in 2012 to target *C. fulgida* var. *mamillata* (coral cactus). A further 16 biotypes were imported from the United States of America and Baja California, Mexico between 2011 and 2015 to target the remaining seven species of *Cylindropuntia* naturalised in Australia. Biological control success is dependent on matching the most effective biotype to the most susceptible target *Cylindropuntia* species. As *Cylindropuntia* species are morphologically variable and hence taxonomically challenging, particularly when the plants are young, molecular analysis was used to allow biotype matching. Designated photo-monitoring plots were also established at three release sites to measure the impact of the insect over time.

All biotypes of *D. tomentosus* have been approved for release and to-date five are currently being mass-reared for future releases, providing an effective management tool for stakeholders nation-wide. The remaining biotypes are still being assessed for their impact on naturalised *Cylindropuntia*. Three of these biotypes have been released at designated monitoring sites to assess their impact. The 'cholla' biotype was released in March 2016 at Longreach (central Queensland) and April 2016 at Hebel (south-western Queensland) and has been highly damaging (Figures 1 and 2). After two years, only six plants in a 1 ha monitoring plot at Longreach are still alive, while 86% of an initial population density of 3990 plants ha^{-1} are dead at the Hebel monitoring site. Due to the level of damage, there is a very low probability that plants will recover, as cladodes are completely desiccated.

There are high expectations for the '*californica* var. *parkeri*' biotype that targets Hudson pear (*Cylindropuntia pallida* (Rose) F.M. Knuth). A monitoring program has been set up at two sites near Lightning Ridge, New South Wales. Molecular analysis has demonstrated that two plastid markers and a nuclear region allow the differentiation of the eight naturalised *Cylindropuntia* species and enables researchers to match targeted *Cylindropuntia* species to the most effective cochineal biotype – a concept that has been described as 'genetic optimisation' (Jones *et al*. 2016). Stakeholders requiring a specific biotype to control their *Cylindropuntia* infestation are encouraged to submit samples of the cactus for molecular identification.

Figure 1. *Cylindropuntia fulgida* var. *mamillata* at 'Leander Station', Longreach, prior to release of biological control agents (2016).

Figure 2. *Cylindropuntia fulgida* var. *mamillata* at 'Leander Station', Longreach post-release (2017).

Chromolaena odorata The gall-fly *Cecidochares connexa* (Macquart) (Figure 3) has achieved excellent control of *C. odorata* in Papua New Guinea and several other countries. It was imported into Australia in 2012 for host-specificity testing against 18 plant species (Day *et al.* 2017). These were in addition to 122 plant species tested in seven other countries prior to release of the insect in those locations.

Host-testing of *C. connexa* has been completed and it has been found to be suitably host-specific. Based on these results, an application to release the gall-fly in Australia was submitted in 2015 and is still being assessed by the Australian Government.

Mikania micrantha The fungal pathogen *Puccinia spegazzinii* de Toni has been imported and tested pre-emptively in case the current eradication program for *M. micrantha* in Queensland is unsuccessful. This

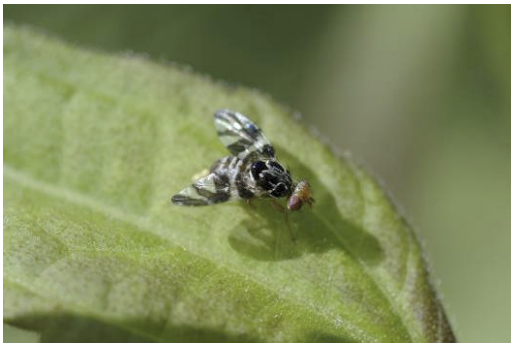

Figure 3. *Cecidochares connexa* (Image courtesy C. Wilson.)

Figure 4. *Rhembastus* sp., a new agent for *Kalanchoe delagoense*.

pathogen has been tested in five countries against a total of 273 plant species with no non-target impacts (Day *et al*. unpublished data). It was imported from Papua New Guinea in 2015 and has been tested on 14 plant species in the tribe Eupatorieae and six species in the tribe Heliantheae.

Testing of the pathogen has been completed with host specificity being confirmed. An application for release in Australia will be lodged in 2018.

Kalanchoe delagoense Exploration was conducted in Madagascar to find suitable biocontrol candidates for *K. delagoense*. In 2017, the leaf and root-feeding beetle *Rhembastus* sp. (Figure 4), was imported into quarantine from Madagascar and its biology and host-specificity is being studied.

The adults of this insect feed on the leaves and plantlets produced at the end of the phyllodes and deposit their eggs within the root system of the plant. Upon emergence, larvae feed on the roots of the plant. Previous host-specificity testing in South Africa demonstrated that the insect could complete development on five non-target species in the Crassulaceae family. Despite this, the insect still has potential in Australia, as there are only eight native species in the Crassulaceae family (Witt *et al*. 2006). Once the biological requirements of the insect have been established under quarantine conditions, the project will move onto the host-specificity testing phase to assess suitability.

***Sporobolus* spp.** Researchers at Rhodes University in South Africa have been contracted to conduct field exploration to find suitable agents for the biological control of *Sporobolus* species. As Australia has a number of native congeners, particular attention is being given to native range field-host testing and molecular studies to help identify suitable candidates for detailed testing under laboratory conditions. Recent exploration in South Africa has found several species of stem- boring insects. More detailed host-specificity testing will be conducted pending field studies.

Solanum torvum* and *Senna tora Two new projects will undertake exploration in South America and south-east Asia for potential biocontrol agents for these two weed species. The work is being funded by the New Zealand Government. This project has not yet commenced, however any agents identified during prospecting may be of value to Australia's future biological control research. This is a good example of overseas work benefitting Australian biological control projects and providing a significant cost-saving for the exploration phase of the project.

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