Australian Government
Land & Water Australia

# A commentary on funded biological control projects

Bruce Auld

## Overview

In a suite of 27 national weeds research projects funded as part of the "Defeating the Weed Menace Program", Land & Water Australia funded seven projects under the theme "Biocontrol agents for national priority weeds". The projects related to weeds in all states and territories and included insects and fungi as control agents:

- **CEN7** — Enhancing noogoora burr biocontrol in northern Australia
- **CEN8** — Boneseed rust: A highly promising candidate for biological control
- **CEN11** — Biological control and ecology of alligator weed
- **CEN12** — Development of new biocontrol agents for parkinsonia
- **SARDI1** — Importation, rearing and field release of the Cape broom psyllid
- **UWO7** — Improving management of salvinia in temperate aquatic ecosystems
- **VPI10** — Importation and release of a new biological control agent for Scotch broom

In addition, two projects under other themes, involved assessments of biological control of weeds:

- **CEN23** — Optimising management of core mesquite infestations across Australia
- **CEN24** — Evaluating the environmental benefits from managing WoNS in natural ecosystems

These nine projects embraced the whole range of activities involved in classical biological control research and implementation, including:

1. Exploration overseas for potential candidate organisms.
2. Host range and efficacy testing of potential agents.
3. Importation of new agents.
4. Release of new agents.
5. Augmentative releases with agents already introduced.
6. Evaluation of agents released in the field.

The research projects met issues frequently encountered in biocontrol projects in Australia over many years:

1. The need for a long-term commitment in terms of both time and money to achieve a successful outcome.
2. The value in supporting projects that have reached a critical stage but lack future funding.
3. Logistical and legal problems involved in working in, and importing organisms from, several countries, as well as limited taxonomic knowledge of endemic flora and fauna in those countries.
4. Uncertainty in relation to host range of potential agents including genetic variation in target weed in native range.
5. Unpredictability in terms of efficacy of an agent once it is released into a new environment.
6. Unpredictability in terms of impact of successful biocontrol on either production or ecosystem recovery.

Cover photo: Cape ivy replacing bridal creeper following successful biological control at Broulee, New South Wales. Photo Louise Morin, CSIRO Entomology. Above: Mesquite (*Prosopsis*). Photo LWA.

## Highlights

One project, VPI10, resulted in the importation, mass rearing and release of a new but previously approved biological control agent, the broom mite *Aceria genistae*, for control of Scotch broom *Cytisus scoparius*. The agent has been released in Victoria, South Australia and Tasmania and a release kit has been developed.

The boneseed rust (a systemic fungus) *Endophyllum osteospermi* (CEN8) has been imported from South Africa into quarantine for efficacy evaluation and host range testing. Although previously thought to take up to three years to produce disease symptoms on host boneseed plants *Chrysanthemoides monilifera* ssp. *monilifera* research has revealed that symptoms may be produced much earlier on some plants. A PCR (polymerase chain reaction) technique has been developed to detect whether the fungus has infected symptomless plants. These two findings will lead to a much quicker evaluation of the agent.

Exploration in Brazil, Ecuador and Peru, as well as finalising surveys in Central and North America and processing material from earlier surveys in Argentina and Paraguay has identified 50 new insect species associated with parkinsonia *Parkinsonia aculeate* (CEN12). From these, a prioritised list of 10 potential biocontrol agents for the weed has been developed as a basis for future work.

## Other findings

New strains of the rust fungus *Puccinia xanthii* were imported from the Dominican Republic and Mexico as potential biocontrol agents for noogoora burr *Xanthium occidentale* in northern Australia (CEN7) in an attempt to find agents from similar climates. These strains did not infect Australian noogoora burr, highlighting the difficulties in matching agents with target weeds of both widespread origin and extensive distribution in Australia. In Australia, noogoora burr is a complex of four species of different origins in North and South America and unique hybrids may occur here, although the plants in northern Australia are apparently all one species *X. occidentale*. In the Americas, similar *Xanthium* species occur from Canada to Argentina. Similar problems could arise with parkinsonia, another species with a wide native range.

Highly invasive foreign plants like Scotch broom (*Cytisus scoparius*) chew up huge amounts of time and money on a daily basis around Australia as landowners and park managers fight to control and eradicate them. It might look like a native wattle from afar but Scotch broom infests some 200,000 hectares of Australia, including the World Heritage-listed Barrington Tops National Park, NSW. Background photo Roger Charlton. Inset photo Mel Schroeder.

*Xanthium occidentale*. Photo Ian Dixon.

Alligator weed. Photo Shon Schooler.

Witches' broom caused by the rust fungus *Endophyllum osteospermi* on a boneseed plant. Photo Louise Morin, CSIRO Entomology.

A potential biocontrol agent for alligator weed *Alternanthera philoxeroides*, a tip gall fly *Clinodiplosis alternantherae* failed host range tests by attacking two native plant species and will not be released. This project (CEN11) encountered difficulties in importing agents from Argentina and host range testing of two other potential agents: *Ophiomya morelli* (leaf mining fly) and *Systena nitenula* (beetle), are still awaiting completion. A new potential agent, a fungus *Uredo pacensis* from Bolivia, was also identified during this project. Again, this project has revealed genetic complexity in the target weed. There are at least three genotypes of alligator weed originating from Argentina in Australia. Fortunately these races apparently do not reproduce sexually here. Notwithstanding this, the finding emphasises the need for continued quarantine surveillance and exclusion for weeds already in Australia.

A project (SARDI1) aimed to import the Cape broom psyllid *Arytinnis hakani* to control Cape or Montpellier broom *Genista monspessulana* took a sharp change in direction when the psyllid was discovered to already be in Australia in the Mount Lofty Ranges. Subsequent host range tests suggest that the agent could be redistributed to other states.

Another project with a focus on mass rearing/redistribution, the augmentative approach to biocontrol, was conducted on the aquatic fern, salvinia *Salvinia molesta* (UW07). A biocontrol agent, the weevil *Cyrtobagous salviniae* already released with success in northern regions was investigated for distribution in temperate areas. Although temperatures lower than 20°C prevented larval development, factors other than temperature apparently also influence weevil activity.

## Impact of biological control

A study of the effect of management techniques on control of mesquite *Prosopsis* spp. (CEN23) showed that of three biocontrol agents released only one, the leaf tying moth *Evippe* sp. was having an impact. Mesquite consists of three species and hybrids that occur over vast areas of northern Australia. The moth's impact was greatest on hybrid mesquite in the Pilbara but other management of mesquite will be required to capitalise on the damage caused by the moth.

In areas where biocontrol of salvina had occurred (UW07) replacement of salvinia was frequently by another exotic weed *Egeria densa* dense water weed.

An evaluation of benefits from controlling Weeds of National Significance (CEN24), demonstrated that there are very few documented cases where responses and recovery were monitored. In a case study of the impact of the rust fungus *Puccinia myrsiphylli* on recovery of areas invaded by bridal creeper *Asparagus asparagoides* it was noted that whilst bridal creeper cover had decreased, there was an increase in bare areas and leaf litter and a slight increase in both native and weed species.

Above: Close-up of an adult of the leaf-feeding beetle (*Zygogramma bicolorata*) feeding on parthenium weed. Photo K. Dhileepan, Department of Primary Industries and Fisheries, Queensland.
Below: Gorse spider mite (*Tetranychus lintearius*); a biological control of gorse. Photo Peter Martin.

## Lessons and future prospects

The outcomes of the funded projects confirmed that while biological control is a highly suitable and desirable method for weed control in Australia, it is not a "silver bullet" that is a complete answer to weed management. Unpredictability in efficacy of agents, once released, remains as a limitation.

Control of a weed does not, in itself, necessarily lead to increased production or its replacement by desirable plants. Biological control must be integrated with other weed management tactics for successful production and biodiversity outcomes.

There is an urgent need for improved monitoring and evaluation of biological control of weed programs. Follow-up monitoring after release of agents should be built into research program plans. Investment in these activities should be increased although current short-term funding cycles do not encourage long-term evaluation.

This program has supported some projects that will clearly benefit from further funding to progress them towards completion (CEN8, CEN11, CEN12). With limited resources, future research efforts should target priority weeds where chances of success are considered relatively high.

The table on the following pages shows the weeds on which there has been some level of biological control research over the last decade. Of the 52 species (or groups, e.g. *Sida* spp.) at least 23 have been worked on for a much longer period (e.g. *Lantana camara*).

Clearly, research efforts and funding could be more focused on fewer target species. With this in mind, this program commissioned a project to assist in prioritising future research into biological control of weeds: "Improved targeting of weed biological control projects". A report on that project will be available on Land & Water Australia's website (lwa.gov.au) and will be widely disseminated to program and policy managers at national and state levels.

**Please note: The table on the following pages is simply a summary overview. Evaluation of releases or impact is not included. For details of specific programs please contact the researchers involved.**

## Australian biocontrol projects: 1998–2008

| Target species or group | Common name | Institutions involved (generally self-nominated) | Current status* | | | | |
|---|---|---|---|---|---|---|---|
| | | | NA | OH | RS | RL | RD |
| *Alternanthera philoxeroides* | alligator weed | csiro, nsw dpi, dpi vic | | | X | X | |
| *Xanthium spinosum* | bathurst burr | csiro, nsw dpi | X | | X | | |
| *Jatropha gossypiifolia* | bellyache bush | csiro, dpi&f qld | | | X | X | X |
| *Chrysanthemoides monilifera* ssp. *rotundata* | bitou bush | csiro, nsw dpi, dpi vic | | | X | X | X |
| *Rubus* spp. | blackberry | csiro, dpi vic, nsw dpi, rmit | | | X | X | X |
| *Heliotropium amplexicaule* | blue heliotrope | csiro | | | X | X | X |
| *Chrysanthemoides monilifera* ssp. *monilifera* | bonessed | csiro, dpi vic | | | X | X | |
| *Asparagus asparagoides* | bridal creeper | csiro, dpi vic, nsw dpi | | | | X | X |
| *Cabomba caroliniana* | cabomba | csiro | | | X | | |
| *Cassinia* spp. | cassinia | nsw dpi | X | | | X | |
| *Macfadyena unguis-cati* | cats claw creeper | dpi&f qld, nsw dpi | | | X | X | X |
| *Nassella neesiana* | chilean needlegrass | dpi vic | | | X | | |
| *Rumex* spp. | docks | dpi vic | | | | X | |
| *Emex* spp. | emex | csiro | X | | | X | |
| *Senecio madagascariensis* | fireweed | csiro | | X | | | |
| *Fumaria* spp. | fumitory | csiro, nsw dpi | | X | | | |
| *Ulex europaeus* | gorse | tiar tas, dpi vic, csiro | | | X | X | X |
| *Baccharis halimifolia* | groundsel bush | dpi&f qld | | | X | X | |
| *Marrubium vulgare* | horehound | dpi vic | | | X | X | |
| *Hyptis suaveolens* | hyptis | csiro | X | | X | | |
| *Cylindropuntia rosea* | hudson pear | nsw dpi | | | X | | |
| *Lantana camara* sens. lat. | lantana | dpi&f qld, nsw dpi | | | X | X | X |
| *Lantana montevidensis* | lantana, creeping | dpi&f qld | | X | | | |
| *Phyla nodiflora* | lippia | csiro | | | X | | |
| *Anredera cordifolia* | madeira vine | dpi&f qld | | | X | | |
| *Prosopis* spp. | mesquite | csiro, dpi&f qld | | | X | X | |
| *Mimosa pigra* | mimosa | csiro, nretas nt | | | X | X | X |
| *Genista monspessulana* | montpellier broom | csiro, dwlbc sa | | | X | X | X |
| *Bryophyllum* spp. | mother-of-millions | dpi&f qld | | X | X | | |
| *Carduus nutans* ssp. *nutans* | nodding thistle | csiro, nsw dpi, dpi vic | | | | X | |
| *Xanthium occidentale* | noogoora burr | csiro, nretas nt, dafwa, dpi&f qld | | | X | X | |
| *Moraea* spp. | one/two leaf cape tulips | csiro | | X | | | |

## Australian biocontrol projects: 1998–2008 (continued)

| Target species or group | Common name | Institutions involved (generally self-nominated) | Current status* | | | | |
|---|---|---|---|---|---|---|---|
| | | | NA | OH | RS | RL | RD |
| *Onopordum* spp. | onopordum thistles | csiro, dpi vic, nsw dpi | | | | X | |
| *Parkinsonia aculeata* | parkinsonia | csiro, uni qld, dpi&f qld | | | X | | |
| *Parthenium hysterophorus* | parthenium | dpi&f qld | | | | X | |
| *Echium plantagineum* | patersons curse | csiro, nsw dpi, dpi vic, sardi, wa dpi | | | | | X |
| *Physalis viscosa* | prairie ground cherry | dpi vic | | | X | | |
| *Acacia nilotica* | prickly acacia | dpi&f qld | | | X | X | |
| *Senecio jacobeae* | ragwort | dpi vic | | | | X | |
| *Carthamus lanatus* | saffron thistle | csiro | | | X | | |
| *Salvinia molesta* | salvinia | csiro, nsw dpi | | | | X | X |
| *Cytisus scoparius* | scotch broom | csiro, nsw dpi, dpi vic | | | X | X | |
| *Euphorbia paralias* | sea spurge | csiro | | | X | | |
| *Nassella trichotoma* | serrated tussock | dpi vic | | | X | | |
| *Senna obtusifolia* | sicklepod | dpi&f qld | X | | | | |
| *Sida* spp. | sidas | csiro | | | | X | |
| *Solanum elaeagnifolium* | silver leaf nightshade | dpi vic | | | X | | |
| *Sonchus oleraceus* | sowthistle | csiro | X | | X | | |
| *Sporobolus* spp. | sporobolus grasses | dpi&f qld | X | | | | |
| *Hypericum perforatum* | st john's wort | csiro, nsw dpi, dpi vic | | | | X | |
| *Eichhornia crassipes* | water hyacinth | csiro, nsw dpi | | | X | X | X |
| *Raphanus raphanistrum* | wild radish | csiro | X | | X | | |

***** Current status: opinions on this sometimes varied between respondents.
**NA** Non active: program abandoned (various reasons)
**OH** On hold: no active research current; program awaiting funding; administrative +/or staff constraints
**RS** Research: pre release research; searching; host range testing
**RL** Released: at least one agent released at some time
**RD** Redistribution: continuing redistribution/breeding of released agents by researchers

Other potential targets mentioned by respondents:

| | |
|---|---|
| *Ageratina riparia* | mistflower |
| *Euphorbia paralias* | sea spurge |
| *Opuntia robusta* | wheel cactus |
| *Sagittaria graminea* (two ssp.) | sagittaria; arrowhead |

**Acronyms** (in alphabetical order)
**csiro**: Commonwealth Scientific and Industrial Research Organisation. **dafwa**: Department of Agriculture and Food, Western Australia. **dpi&f qld**: Department of Primary Industries and Fisheries, Queensland. **dpi vic**: Department of Primary Industries, Victoria. **dwlbc sa**: South Australian Department of Water, Land and Biodiversity Conservation. **nretas nt**: Northern Territory Department of Natural Resources, Environment, The Arts and Sport. **nsw dpi**: NSW Department of Primary Industries. **rmit**: Royal Melbourne Institute of Technology. **sardi**: South Australian Research and Development Institute. **tiar tas**: Tasmanian Institute of Agricultural Research. **uni qld**: University of Queensland. **wa dpi**: Western Australian Department for Planning and Infrastructure.

PRODUCED BY LWA'S WEEDS R&D PROGRAM. FUNDED BY THE AUSTRALIAN GOVERNMENT'S DEFEATING THE WEED MENACE PROGRAM.

**Acknowledgements**

Thanks to several colleagues who provided information, including: Mike Day, Tim Heard, Royce Holtkamp, David McLaren, Louise Morin, Bill Palmer, Shon Schooler, John K. Scott, Andy Sheppard, and Rieks D. van Klinken.

For more weeds documents — lwa.gov.au/weeds

Photo: This rare white Coast Swainson Pea (*Swainsona lessertiifolia*) is flowering abundantly in restored coastal Banksia woodland after a five year management program targeting bridal creeper. Photo Mae Adams, Venus Bay, Victoria.

Printed on Revive Silk which is made in Australia from elemental chlorine free pulp with 65% derived from sustainable plantation forests and 35% recovered fibre. It is PEFC Certified and Australian Paper is an ISO 14001 certified mill which utilises renewable energy sources.

Published by: Land & Water Australia
Web: www.lwa.gov.au
ISBN print: 978-1-921544-57-6
ISBN electronic: 978-1-921544-58-3


This publication can be ordered free of charge from CanPrint Communications, freecall: 1800 776 616, or e-mail: lwa@canprint.com.au and quote product code **PN22364**

Photos: Front page, Louise Morin
Design: Angel Ink
Print: Paragon Printers, June 2009