SAPIA NEWS

SOUTHERN AFRICAN PLANT INVADERS ATLAS

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WORKING FOR WATER

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100 years of Biological Control of Invasive Alien Plants in South Africa

2013 marks the 100th anniversary of the first biological control programme against an invasive alien plant in South Africa, with the release of a cochineal insect against drooping prickly pear that had formed extensive infestations along the coast from Cape Town to KwaZulu-Natal.

In the past 100 years, biocontrol programmes have been initiated against more than 50 plant species and have provided complete to substantial control of 27 species. These species include several notoriously invasive cacti such as sweet prickly pear and jointed cactus, as well as the mat-forming floating aquatic invaders—such as water hyacinth, salvinia and red water fern.

Whereas SAPIA News 21 gave an historical perspective as well as the status of the various programmes, this edition of SAPIA News takes a look at some of the remarkable efforts in mass-rearing and distribution of biocontrol agents, and successes with the biocontrol of alien acacias.

Biological control began in South Africa in 1913 with the release of a cochineal insect against drooping prickly pear, *Opuntia monacantha*, previously known as *O. vulgaris*.

Biological weed control is the use of natural enemies such as insects, mites and pathogens, to reduce the vigour or reproductive potential of an invasive alien plant. Natural enemies that are used for biological control are called biocontrol agents.

The alien acacias are amongst the most widespread and abundant invasive species in South Africa, occurring in every province, dominating landscapes and watercourses. Biological control, mainly using agents that curb seed production, has already been very successful yet the overall impression is that nothing has changed. Wrong! See pages 4–6 where Prof John Hoffmann explains that there is much more to the biocontrol of acacias than meets the eye!

Fact sheets with descriptions and photos of about 600 plant species can be found at the Weeds and Invasive Plants website: www.agis.agric.za/wip. Requests for information from the SAPIA database and submission of records of invasive plants should be sent directly to Lesley Henderson at L.Henderson@sanbi.org.za.

Mass-rearing of Biocontrol Agents at SASRI

Des Conlong and Denise Gillespie, South African Sugarcane Research Institute

The Working for Water funded mass-rearing centre is based at the South African Sugarcane Research Institute (SASRI) in Mount Edgecombe in KwaZulu-Natal.

SASRI, with its specialized entomological skills, has proven to be highly efficient in the mass production of weed biocontrol agents.

Aquatic weed biocontrol agents are reared on their host plants in portable pools and the terrestrial agents in portable greenhouses and old water settling tanks converted into shade houses. A new laboratory, office and ablution complex was commissioned in June 2012.

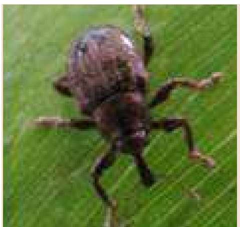
Biocontrol agents currently reared are:

Aquatic weed	Biocontrol agent	Mode of action
Water hyacinth (*Eichhornia crassipes*)	*Neochetina bruchi* *Neochetina eichhorniae* *Cornops aquaticum*	Stem, rhizome borer Stem, rhizome borer Leaf feeder
Water lettuce (*Pistia stratiotes*)	*Neohydronomus affinis*	Leaf feeder
Salvinia (*Salvinia molesta)*	*Cyrtobagous salviniae*	Leaf feeder, stem borer


Portable pools for aquatic weeds

Terrestrial weed	Biocontrol agent	Mode of action
Pereskia (*Pereskia aculeata*)	*Phenrica guérini*	Leaf feeder
Bugweed (*Solanum mauritianum*)	*Anthonomus santacruzi*	Flowerbud feeder
Lantana (*Lantana camara* complex)	*Coelocephalapion camarae* *Longitarsus bethae*	Petiole galler Root feeder
Chromolaena (*Chromolaena odorata)*	*Lixus aemulus*	Stem borer
Parthenium (*Parthenium hysterophorus*)	*Puccinia xanthii* var. *parthenii-hysterophorae*	Leaf rust pathogen

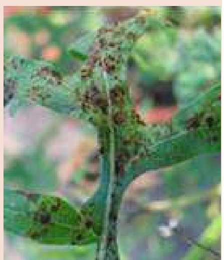

Shade house and greenhouses


Neochetina bruchi


Cornops aquaticum


Phenrica guérini


Coelocephalapion camarae


Puccinia rust

Mass-rearing of Biocontrol Agents at SASRI continued

Packaged agents for release

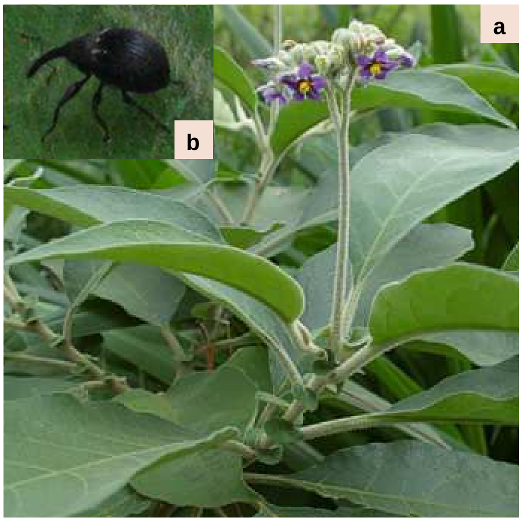
Biocontrol agents are dispatched by courier all over South Africa on request for release against problematic invasive weeds. SASRI undertakes monitoring at sites in the Kruger National Park, Limpopo, Mpumalanga and local sites in KwaZulu-Natal. A total of over 550 000 biocontrol agents have been produced for release over the 2010 to 2013 contract period.

Monitoring of establishment and spread of the agents on the weeds is the first step in successful biocontrol. The public can become part of this, as many "eyes " make monitoring easier. Visits to the SASRI mass rearing facility are encouraged, for training in identification of agents, their specific damage and presence. Information sheets of these relevant agents are available on the ARC-PPRI website (www.arc.agric.za).

Some new candidate agents planned for mass-rearing are: a shoot tip galler (*Dichrorampha odorata*) on chromolaena, a stem borer (*Listronotus setosipennis*) on parthenium, and a sap sucker (*Megamelus scutellaris*) on water hyacinth.

The Bugweed Flowerbud Weevil (*Anthonomus santacruzi*)

Des Conlong and Denise Gillespie, South African Sugarcane Research Institute



Bugweed (*Solanum mauritianum*) (**a**), is a major weed in the high rainfall areas of eastern South Africa. Seed set is extremely high and dispersal is mainly by fruit-eating birds. Anthonomus (*Anthonomus santacruzi*), a small (2–3 mm) black snout-beetle or weevil (**b**), is a very promising biological control agent which prevents fruit set and reduces the enormous potential for seed dispersal. Anthonomus is being reared at SASRI.

Adults (**c**) move around actively on leaves and flowers and are able to fly and disperse well. Female weevils (**d**) chew into buds and lay their eggs in small cavities hollowed out in the sides of the anthers of both immature and mature buds. The small larvae (**e**) develop within the anthers at first, and then consume the entire contents (petals and anthers) of the flowerbuds as they develop. Feeding inhibits the opening of the buds and fruit development. The emerging adults chew their way out of the buds in which they have developed, leaving emergence holes (**f**).

In the absence of flowers, the weevils feed on the apical leaflets and shoots, causing considerable damage.

Adults move freely on flowers and leaves

Adults feeding on flowers and buds

Larva inside flowerbud

Emergence holes in infested buds

Initial releases of Anthonomus were made in KwaZulu-Natal in 2008 and 2009 by Terry Olckers, of the University of Kwazulu-Natal, Pietermaritzburg. Releases commenced from the mass-rearing facility at SASRI in July 2011, along the KwaZulu-Natal coast and midlands, followed by Mpumalanga, Eastern and Western Cape, Limpopo and Gauteng. Establishment has been confirmed on the Kwazulu-Natal south coast, the Durban area and Mpumalanga. Further monitoring is required to determine establishment and spread of Anthonomus.

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More than 14 000 weevils have been released from the SASRI culture, and a further 13 000 weevils have been collected from established areas and have been re-distributed. With the rapid rate of establishment and spread it is anticipated that mass-rearing will no longer be a necessity.

Biological Control of Australian Acacias: what you see is not what you get!

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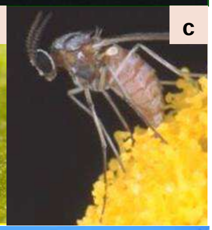
Biological control of invasive Australian acacias started in 1982. The policy has been to tackle species simultaneously because when one is removed from an area another often takes over. To date, 10 agent species have been released on 10 *Acacia* species (and also the closely related stink bean (*Paraserianthes lophantha*). They include two flower-bud gall wasps (**a**), five seed weevils (**b**), two flower gall midges (**c**) and a rust fungus. The latter is the only agent which ultimately kills its host plant. The other nine species primarily reduce seed production and have little or no effect on growth or survival.



Biocontrol of acacias has been aimed primarily at reducing seed production without otherwise damaging the plants. This is a deliberate tactic to preserve existing plants so that they can continue to be used for the production of tannin, paper, firewood, charcoal and furniture.

This raises the question of how useful agents that only reduce seed production are, especially since invasive acacias are perennial trees which produce copious quantities of long-lived seeds each year? Sceptics answer that not much has been achieved because there are still plenty of invasive acacias about and cynics feel the exercise has been rather futile.

So what can we realistically expect from biological control with seed-reducing agents? An immediate effect of reduced seed production in any plant species is that its dispersal ability will be curtailed. This effect is not easy to quantify but there is considerable evidence to support this assertion. As a result, areas not yet invaded by acacias are much less vulnerable to invasion as the biological control agents routinely reduce seed production to less than a tenth of what it was. This alone is a major benefit because pristine habitats, or areas cleared of scattered plants, will be much easier to retain.

Biocontrol agents routinely reduce seed production to less than a tenth of what it was, which in turn curtails dispersal ability and the invasion of new areas. The density and extent of some of the acacias are on the wane due to biological control.

The ultimate prize in biological control is a reduction in the density and extent of the targeted weed species. Is this happening in the case of the acacias? All we can say is that it's a slow process. Depriving a perennial plant of its seeding capacity is bound to elicit a gradual response on density, especially when there are prolific accumulations of long-lived seeds in the soil.

Following biocontrol, seed of rooikrans (*Acacia cyclops*) (**c**), is a rare sight and flower-galls (**d**) are a common sight

A seed weevil (**a**) and flower-gall midge (**b**) have been used to reduce seed production of rooikrans (*Acacia cyclops*), which forms extensive stands along the coastline of the Western and Eastern Cape Provinces.

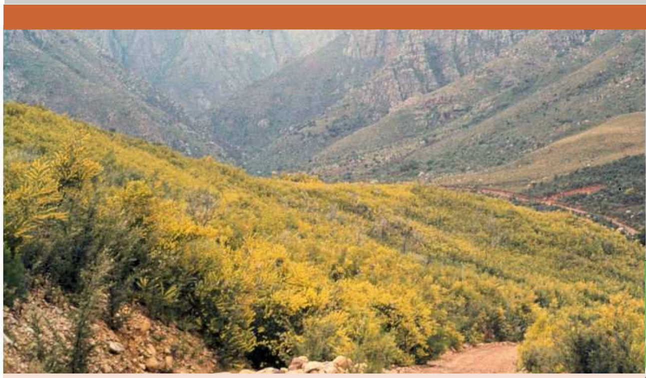
Biocontrol of Australian Acacias continued

Long-term studies on rooikrans (*Acacia cyclops*), are showing that seed banks in the soil disappear completely after fires (most seeds are scorched and destroyed during the fire, the rest germinate within two years). The result is that after every fire the clock is reset and the system starts with a clean slate. Historically the new plants would start to produce seeds after three to four years and seed banks would accumulate until they reached thousands of seeds per square metre. There would have been many more seeds but native granivores, particularly mice and birds, destroy a portion of each year's crop. Since the introduction of a seed weevil and a flower-gall midge onto rooikrans, the pattern has changed dramatically. Infestations that burnt 10 years ago (when the flower-gall midge was rising to prominence) have practically no seeds in the soil. The few seeds that are being produced, in spite of the agents, are being snapped up by 'frustrated' mice and birds that used to flourish on a huge surplus of seeds. Thus if a second fire sweeps through areas that burnt in the last 10 years, re-establishment of rooikrans is expected to occur at very low densities.

Rooikrans before biocontrol : 2000–10 000 seeds m^{-2}

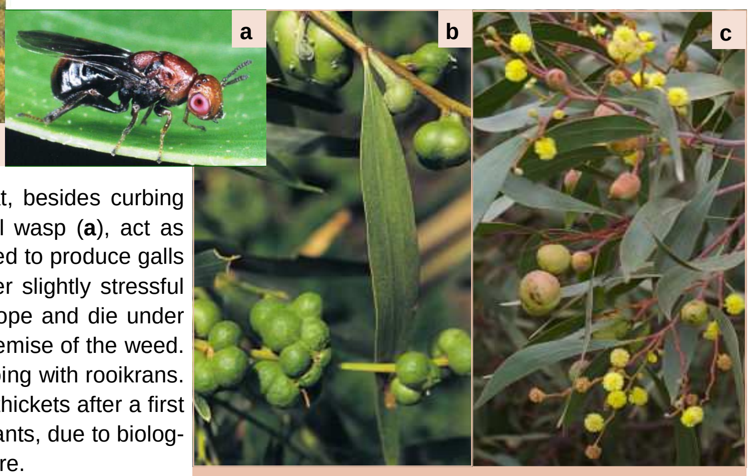
Fire scorches at least 98% of seeds, and biocontrol drastically reduces the further accumulation of seed.

With biocontrol each successive fire leads to fewer seeds and a decline in rooikrans, reducing thickets to scattered plants.



Infestation of long-leaved wattle, *Acacia longifolia*, in the 1980s

The longest running of the biological control programmes, that against long-leaved wattle (*Acacia longifolia*), is providing circumstantial evidence that the rooikrans story will unfold as anticipated. In the 1970s and 80s, long-leaved wattle regularly featured at the top of the rankings of the most problematic invasive species in South Africa. Today it remains abundant in some areas but for the most part is of very little cause for concern.



Bud-galls on long-leaved wattle (*Acacia longifolia*) (**b**) and golden wattle (*Acacia pycnantha*) (**c**), curb seed production and act as nutrient sinks. All indications are that biocontrol will also prevent golden wattle from proliferating and becoming a problem.

Early work by George Dennill, of the ARC-PPRI, showed that, besides curbing seed production, the galls formed in response to the bud-gall wasp (**a**), act as nutrient sinks because more of the plant's resources are required to produce galls than are required to produce seed pods. Plants growing under slightly stressful conditions (low nutrients or low moisture availability) cannot cope and die under the heavy loads of galls. Certainly this has contributed to the demise of the weed. However, fire has probably also played a role, much like it is doing with rooikrans. Once again the accumulated seed banks are able to replenish thickets after a first fire but with limited seed production in the next generation of plants, due to biological control, there is a pattern of decline with each subsequent fire.

Hillsides once smothered with long-leaved wattle are now almost devoid of the plant, 30 years after the introduction of biological control.

Biocontrol of Australian Acacias continued

Going forward there is a very exciting development unfolding with the new flower gall midge (**a**) on black wattle (*Acacia mearnsii*). The midge is a slow starter, having only one generation a year, but now that it is up and running things are happening fast. Galling on the trees reaches exceptional levels and seed production has practically stopped at several sites in the Western Cape, so much so that it's hard to see how the seed weevil that was released earlier is going to get a look in. So here is one of the country's worst invasive species looking at a potential future with hardly any seeds. Surely the problem cannot get any worse, which is excellent news, but there is also no reason to doubt that in a number of years, as fire takes its toll, black wattle will only persist in non-flammable enclaves and at much lower levels than we are accustomed to now.

Flowers of black wattle (*Acacia mearnsii*) are replaced with galls (**b**) instead of pods with seeds (**c**).

Seed reduction and repeated fires will ultimately restrict black wattle to non-flammable habitats and to much lower densities.

In Stellenbosch, where the gall midge has been established for the longest time, seed rain below a black wattle tree has declined to very low levels.

So while the evidence is not yet cut and dry, every indication is that biological control is providing huge benefits in the case of Australian acacias – all we need is to stop looking at what's left (the remnants of the problem) and rather relish the gains that have been made, and will continue to be made increasingly in future, because we have biological control.

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The Weeds Research Programme of the ARC-Plant Protection Research Institute is responsible for research on the ecology and control of invasive alien plants in South Africa. These plants were introduced either intentionally (e.g. for ornamental use or agroforestry purposes), or accidentally (e.g. in livestock feed) and now threaten biodiversity and agriculture. In addition, they reduce run-off from water catchments, thus diminishing flow in streams, and adversely affect the quality of life of communities.

- Biological control
- Chemical control
- Bioherbicides
- Integrated control
- Monitoring the emergence and spread of invasive alien plants

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Invasive alien plants

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