Biological control: managing risks or strangling progress?

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Summary Australia has been one of the top countries in the world in the biological control of weeds. Since the first introduction in 1914, there have been many successful control programs and very few problems. Biological control is cost-effective and results in long-term sustainable control; however, the introduction of new living organisms into a country necessarily involves some risks. For this reason, there have always been strict controls on the process.

Recent problems with unpredicted non-target effects, both in Australia and New Zealand, and in the Americas, have led to demands for further controls. In an increasingly litigious society, governments and bureaucracies are becoming increasingly risk-averse. Their response is to demand a no-risk situation where there is no exposure to possible liability. Legitimate biological control is increasingly strangled by new controls, while real environmental damage continues unchecked, and there is an increased risk of illegal and uncontrolled introductions.

In this situation, we need rational decision-making and proper assessment of the risks involved without hysteria and media hype. Senior bureaucrats with the backing of politicians have the responsibility to make the difficult decisions: both groups need the moral courage to accept a degree of risk.

Keywords Biocontrol, risk analysis, non-target damage.

INTRODUCTION

Biological control of weeds using introduced insects and, later, pathogens has a long and successful history in Australia. The first deliberate introduction was the cochineal insect *Dactylopius ceylonicus* (Green) in 1914, which resulted in the successful control of drooping tree pear *Opuntia vulgaris* Miller. This was followed in the 1920s by the introduction of up to 30 separate insect species, and the successful control of common pest pear *Opuntia stricta* (Haworth) by the moth *Cactoblastis cactorum* (Bergroth), and of other cacti by this moth and different *Dactylopius* species. Careful testing was undertaken with each insect to ensure that they would not feed on other plants. Australia was the first country in the world to use these tests, and has continued their use ever since.

After the great success of the prickly pear control, governments and scientists in Australia continued to support biological control, and by the 1980s Australia was a world leader in weed species targeted and new agents introduced (McFadyen 1998). Australia also led the world with the first deliberate introduction of a pathogen, the rust *Puccinia chondrillinae* Bubak & Sydenham released in 1971 to control skeleton weed *Chondrilla juncea* L. Despite the success of this introduction, and the complete absence of attack on non-target plants, doubts about the safety of pathogens stifled further introductions for 20 years, until the release of the rust *Puccinia abrupta* Dietz & Holw. against parthenium weed *Parthenium hysterophorus* L. in 1991. As a result of the complete blocking of the legal pathways, there were two illegal introductions, the rust *Puccinia xanthii* Schweinitz against Noogoora burr *Xanthium strumarium* L. in 1974, and the blackberry rust *Phragmidium violaceum* (Schultz) in 1984. These gave excellent control of Noogoora burr in the high rainfall coastal districts, but only poor control of blackberry.

The 1970s and 80s saw the successful control of the waterweeds water hyacinth *Eichhornia crassipes* (Martius) Solms, salvinia *Salvinia molesta* D.S.Mitchell and pistia *Pistia stratiotes* L., all with insects; of harrisia cactus *Harrisia martini* (Labouret) with a mealybug; of giant sensitive plant *Mimosa invisa* Martius with a psyllid; and partial or developing control of St John's wort *Hypericum perforatum* L., various thistles, *Sida acuta* Burman, and annual ragweed *Ambrosia artemisiifolia* L. In the last decade, successful control is being achieved against ragwort *Senecio jacobaeae* L., groundsel bush *Baccharis halimifolia* L., bridal creeper *Asparagus asparagoides* (L.) W.Wight, rubber vine *Cryptostegia grandiflora* Roxb. ex R.Br., giant mimosa *Mimosa pigra* L., and parthenium weed *Parthenium hysterophorus* L. (Briese 2000). These programs have saved millions of dollars in control costs, and thousands of square kilometres of land, both pasture and national parks, from the damaging impacts of these invasive weeds. Numerous cost-benefit studies have demonstrated the value of the programs, and no negative impacts have been registered from any.

ISSUES

So what is the issue? Why are there questions about such a startlingly successful, cost-effective method, which has had no significant negative environmental,

agricultural or social impacts in nearly 100 years of use in Australia? The problem is poor risk-assessment, well covered in the recent review by Sheppard *et al.* (2003). Much of the following section is a precis of their main points as they relate to Australia.

Perceptions 'Current ecological discussion surrounding biological control focuses relatively little attention on the historical success or the potential future environmental benefits' (Sheppard *et al.* 2003 p. 92). Instead, there has been 'a series of high profile science articles since 1997 expressing grave concern that biological control has very occasionally caused damaging non-target effects on rare native species (e.g. Louda *et al.* 1997, Pemberton 2000 and Louda *et al.* 2003).' (Ibid p. 104). As a result, 'the benefits of biological control remain poorly understood by the public, allowing the risks to attain disproportionate attention.' (Ibid p. 91).

Within Australia, publicity is given to the cane toad as an example of biological control gone wrong. There has been considerable media attention over damage to fiddlewood trees (*Citharexylum spinosum* L., an introduced ornamental widely planted in eastern and southern Australia) by the lantana bug *Acanophora compressa* Walker (Palmer in press, Taylor *et al.* 2004). At the same time, damage by the broom seed weevil *Bruchidius villosus* Fabr. on tagasaste *Chamaecytisus palmensis* (H.Christ.) F.A.Bisby & K.W.Nicholls in New Zealand has raised questions for scientists involved in approval of biocontrol releases.

More recently, scientists have been raising the issue of indirect non-target impacts on native species, that is, flow-on effects through the food-web (Pearson and Callaway 2003). These may occur through native animals feeding on the biocontrol agent and thereby becoming more common, either mammals (Ortega *et al.* 2004) or parasitoids (McFadyen and Spafford Jacob in press), with further flow-on impacts on their predators or prey. These flow-on or indirect impacts are perceived to be a greater risk when the target weed occurs in natural ecosystems rather than cropping areas, and will be greater when the biocontrol agent establishes but provides ineffective control of the weed, so that large populations persist of both agent and weed.

Reactions In the face of these perceived risks, the response is to demand more pre-release evaluation of all possible impacts. Because flow-on indirect impacts are essentially impossible to determine beforehand, given that parasitism and/or predation in the new country is not predictable with present knowledge (McFadyen and Spafford Jacob in press), there are calls to limit the number of agents released (Denoth *et al.* 2002).

As resources are always limited (funding, quarantine space and scientist time), increased demands for pre-release impact assessments leads to reductions in the numbers of potential agents studied and released. During the 80s and most of the 90s, where test results were clear-cut with no development or significant feeding on a native or economically valuable plant, a release permit was usually granted within three to six months of the submission of the final report. Current delays are easily double that, and can stretch into years if staff in any agency, including those without any experience in weed management, raise issues or request further testing.

Biological Control Act (BCA) The BCA is seen by some government policy and legal staff as offering protection against liability for possible damages resulting from biocontrol agents. The Act was passed in 1984 to deal with the conflict of interests resulting from the program for biocontrol of Paterson's curse *Echium plantagineum* L. This weed is also known as Salvation Jane, because it is seen by some as a valuable dry-season fodder for sheep, and as a source of nectar for bees. For this reason, it was not a declared weed in most areas. A group of bee-keepers took out an injunction to prevent CSIRO Entomology from releasing biocontrol agents, not because of possible non-target damage but because they were opposed to the control of the target weed itself (Cullen and Delfosse 1985).

The Act allows for consideration of the public interest in this and similar cases, and for payment of compensation where individuals or groups would be disadvantaged by the results of a biocontrol program. It does not provide any protection against legal liability for damage not foreseen at the time, if caused by negligent testing or failure to disclose results of tests or other information. The Act is seen as difficult to operate, because it requires public enquiries in each State where releases will occur, and consequently has only been used for Paterson's curse, the blackberry rust and rabbit calicivirus.

Several states have suggested the revision of the BCA to make it more workable, and to then use it for all biocontrol releases. The problem is: a) some public enquiry process is essential for any legislation that removes the right to sue for damages; b) no legislation will remove the liability to damages if negligence can be proved, therefore governments could still be sued in the courts if the actual non-target damage suffered had not been adequately predicted at the time of release; c) under current procedures, if proper procedures were followed, i.e. there was no negligence, an action against the responsible government is most unlikely

to succeed – which is why no such actions have been pursued in the courts. The BCA is therefore of value only to resolve conflict over predicted impacts, on the weed or on non-target plants.

Nevertheless, risk-averse government policy staff are increasingly reluctant to proceed unless protection against any possible future liability can be guaranteed. If similar demands were made for road building, or hospital procedures, the processes of governments would grind to a halt overnight, but somehow this has been allowed to become an issue for biological control.

CONSEQUENCES

The combination of increased pre-release assessments plus reluctance by government agencies to authorise releases of new agents has already resulted in significant reductions in agent releases. From 1974 to 2000, an average of five release permits for new biocontrol agents against weeds were issued each year in Australia, with numbers per year varying from two to eleven (data from Sheppard *et al.* 2003). Since 2001, only two release permits have been issued per year (J. Scott pers. comm.). Queensland is one of only two State governments actively involved in importing new biocontrol agents, but senior policy staff have become increasingly uneasy, with recent statements that the risks are too great. This is a potentially disastrous shift, as the Queensland government has historically been one of the most active in weed biocontrol, with more successful programs than any single country except the USA (McFadyen 2000, Walton in press).

Prior to these developments, overseas exploration followed by detailed host-specificity testing typically required one to two full-time scientists (plus support and facilities) for five to ten years, usually resulting in the release of three to eight agents (Harris 1979, McFadyen 1998, Briese *et al.* 2002). In up to 80% of programs, the outcome was successful control of the weed, such that it ceased to be a major invasive problem (McFadyen 1999, Briese 2002). Ecological assessments of potential impacts of each agent will easily double the resources required, with the full cost borne by the proponents. Biological control already suffers from insufficient support, because costs are incurred at the start and benefits take many years, typically far longer than the time span for granting bodies or governments. A doubling of the initial costs will make it correspondingly difficult to obtain financial support for programs.

Even more worrying are the concerns raised over indirect effects, those due to changes in the native food webs. Most scientists agree that these cannot be predicted, therefore (perhaps fortunately) pre-release studies are not the answer. Instead, the view is that only one 'best' agent should be released, until enough time has elapsed for its impacts to be evaluated. If the first agent is not successful, then the next 'best' agent will be released and so on. Denoth *et al.* (2002) found that two to fourteen agents were released in most successful weed biocontrol programs, and, out of 33 successful programs, in only five was success achieved with the first agent released. A requirement that subsequent agents are only released after the first 'best' agent has been demonstrated to be inadequate will delay successful control by between five and 50 years, with the longer delays in temperate climates where agents typically have a single generation per year.

With widespread invasive weeds, delays in successful control for periods of 20 to 50 years means that invasive plants continue to spread and cause increasing damage. Weeds are already costing the livestock industry $1.8 billion a year in lost production (Sinden *et al*. 2004), which represents many thousands of square kilometres of land effectively abandoned to weed invasion. The use of other control methods (herbicides, mechanical) results in increasing economic, environmental and health costs, especially in environmentally sensitive areas such as riparian lands or national parks.

Stifling of legal biocontrol also means that illegal action, with a greatly increased risk of harmful consequences, becomes increasingly probable. There have already been two deliberate illegal importations of weed biocontrol agents into Australia (both pathogens) and the illegal introduction of rabbit calicivirus into New Zealand. All three occurred in response to blockages in the legal pathway. Many successful biocontrol agents could be easily imported illegally; the necessary information is publicly available in reports and on the web. If interest groups know of an effective and host-specific agent, legal importation is blocked, and the weed is having severe environmental or agricultural impacts, they might well decide to try illegal importation. Once an agent is in the country, current legislation does not prevent further distribution. Illegal importations are, however, very undesirable as they carry real risks of mis-identification of agents or contamination with parasites and diseases.

CONCLUSION

Politicians and policy bureaucrats need to understand that no land management actions will ever be without some risk, and, in a democracy, no government action can be completely free of legal liability at least where negligence can be demonstrated. The aim must be to operate with minimal and/or predictable risks. Risk assessment processes need to be complete and

explicit, and must include the current impacts of the weed and alternative control methods, including the impacts of chemicals in the environment, or the erosion and damage to surrounding vegetation resulting from mechanical controls.

Once all risks have been assessed, we need rational decisions to be made, setting aside media hype and hysteria, weighing the risks and then acting on the outcomes. It is the role of governments, including senior bureaucrats, to take decisions and accept the associated risks, and perhaps they need to be reminded of this. Australian governments have a responsibility to support and facilitate the safe and legal use of biocontrol to manage widespread invasive weeds. At present, there is a real danger that a collective failure of nerve will be allowed to block the use of this proven safe and effective method.

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