SCIENCE & RESEARCH INTERNAL REPORT NO.120

BIOLOGICAL CONTROL OF WEEDS IN 1992: A REPORT

by

Susan M. Timmins

Published by
Head Office,
Department of Conservation,
P O Box 10-420,
Wellington
New Zealand

ISSN 0114-2798
ISBN 0-478-01366-3

Keywords: biological control, biocontrol, weeds, international symposium report, conservation

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Susan M. Timmins
Science and Research Division, Department of Conservation,
P.O. Box 10-420, Wellington

ABSTRACT

Biological control of weeds, the control of nuisance plants using animals or pathogens, is a small discipline in New Zealand but is widely practised in other countries so the International Symposium on Biological Control of Weeds held at Lincoln in February 1992 attracted 183 delegates from 20 countries. This report summarises information obtained by attending the symposium. Many weed species are shared by several countries and biocontrol agents are often transferred from one country to another. Conservative screening test procedures have been developed to assess the risk of biocontrol agents attacking non-target plants. Occasionally, however, agents known to attack non-target plants have been introduced when the benefits of the biocontrol were deemed to outweigh the disadvantages of the unwanted plant damage. More often, it is reported that biological control agents have not been damaging enough to the target weed.

The high initial cost of biocontrol and the lack of immediate results is a deterrent to biocontrol programmes in protected natural areas. However, invasion by alien species is among the most serious threats to protected natural areas and the costs of chemical control are prohibitive. Biological control used in concert with other forms of control, offers the best chance of effecting long term control of many of our problem weeds in reserves and this approach should be seriously considered.

1. INTRODUCTION

In February 1992 I attended the VIII International symposium on Biological Control of Weeds at Lincoln University, Canterbury. This report is a mixture of snippets from papers presented at the conference, comments gleaned during informal discussions or workshops, and data from various recently published, significant papers in the field which were either acquired or cited at the conference. The material from the different sources is sprinkled throughout the report under appropriate headings.

Thus the report some of the current issues in biological control of weeds, particularly in relation to conservation of protected natural areas. It is intended for those who want an executive summary on, or introduction to, biological control of weeds. Further, more detailed information can be found in the references cited.

Biological control of weeds is the use of animals (usually insects) and pathogens (disease agents) to reduce the population densities of undesirable plants. It implies the deliberate manipulation of predators and/or parasites by humans to control weeds (Gardner 1990). Classical biological control involves importing an insect or fungus from another country to control a nuisance plant. Often the biocontrol agent is a natural enemy of the weed in its country of origin and it is this lack of its natural predators which has allowed the weedy plant to become a problem.

2. BIOLOGICAL CONTROL ACTIVITY WORLDWIDE

Although biological control of weeds is a small discipline in New Zealand there is much activity elsewhere in the world, with whole teams of people working on just one plant. The symposium attracted 183 delegates from 20 different countries and nine percent of the conference participants worked for institutions dedicated to the biocontrol of weeds. One of the more prominent is CAB International Institute of Biological Control. It has its headquarters at Silwood Park, Ascot in the UK and field stations in Trinidad and Tobago, Switzerland, Pakistan, Kenya and Malaysia. Both Australia and USA have biological control organisations with units established in other countries. CSIRO Australia has a unit in South Africa and one in Montpellier, France. These locations reflect the source of many of Australia's weeds, and thus likely sources of biological control agents. The units have up to 20 staff, predominately local people, with one or two Australians on five year secondment. USA has a unit in Australia.

A paper entitled "Eighty years of weed biocontrol in South Africa: What have we learnt?" demonstrated how much work is, and has been, done. This paper was in part an advertisement for a series of 18 papers on the general theme published in 1991 in a special issue of the journal *Agriculture, Ecosystems* and *Environment.* Julien (1989) is another useful paper on the trends, rates of success and the future of biological control worldwide.

In his world catalogue of biocontrol agents Julien (1987) listed 300 examples in which an insect species has been introduced for the purpose of controlling a weed. This number is likely to be higher today (Julien 1992).

Biological control is now a mainstream form of control in many parts of the world. CAB International publishes a periodical dedicated to the science: *Biocontrol news and information* and there are even basic texts published on the subject. At the conference Harley and Forno (1992) was promoted. It describes how to conduct a biological control programme including selecting target weeds, exploring possible biocontrol agents, quarantine procedures for importing agents, and propagation, distribution and evaluation of biological control agents.

2.1 International Co-operation

The papers at the symposium showed that many weed species are shared by several countries for example biocontrol agents are being considered, in other countries, for several species that are problems in protected natural areas in New Zealand. Insects from Australia and India are being used to control hydrilla (*Hydrilla verticillata*) in USA. Grass carp is being investigated to combat pondweed (*Potomogeton pectinatus*) in South Africa. South African insects are being studied to effect control of bone-seed (*Chrysanthemoides monilifera*) in Australia and a rust fungus will be imported to Australia to control blackberry (*Rubus fruticosus*).

There is plenty of potential for sharing information and fortunately the very nature of the science of biological control engenders international co-operation. This spirit was evidenced in the friendly atmosphere at the symposium and the number of joint papers given by authors from different countries.

Control agents are often sourced from a country where they are already used for biocontrol where they have already been bred to remove unwanted diseases or parasites. For example, the thistle receptacle weevil *(Rhinocyllus conicus),* which was introduced to New Zealand in 1973 to control nodding thistle (*Carduus nutans*) was acquired from Canada who in turn had acquired it from another biocontrolling country who had imported it from its country of origin. A more dramatic example is that of the tingid *Teleonemia scrupulosa* which has been used as a biocontrol agent for lantana *(Lantana camara)* in 22 countries (Julien 1987). The rates of establishment and effectiveness of a biocontrol agent increase with the number of times the agent is imported to another new country (Julien *et al.* 1984).

3. ENVIRONMENTAL DANGERS?

In addition to the large initial cost of biocontrol programmes, a major barrier to the use of biocontrol has always been the perceived environmental threats. Several papers at the symposium analysed the basis for this perception. One suggested that laboratory tests are actually more conservative than field testing, it is possible for an insect to feed on a plant presented to it in the laboratory but not to attack it in the field. Modern screen testing for biological control agents employs a "centrifugal" test in which insects are offered plants of increasingly distant relationship to the host. From these tests the host range limits of the insects are determined and the vulnerability of any plant can be predicted (Harris 1988). These feeding tests establish if an insect will feed or establish on the plants tested in the laboratory, but that does not necessarily translate into damage in the field. The three requirements which are necessary for an insect to use a plant in the field are:

1. The plant must support insect development.

2. The insect must have the opportunity to attack the plant i.e. the ecological and climatic requirements of the insect must match the occurrence and vegetation development of the plant. An insect which lives in dry, alpine areas is unlikely to attack plants that live in moist lowland areas in the field even if it does so in the laboratory.

3. It must be advantageous for the insect to consume the plant. There is no selective advantage for the use of a poor or uncommon host.

This last point is the counter to concern about rare native plants. Their very rarity would make them less prone to attack than the abundant weed species (see also Harris 1988). The only specialist predator whose search for the prey increases in intensity as the prey becomes rare is the human collector (Harper 1981).

Despite this reassuring analysis, other papers pointed to the possibility that species that are poor hosts initially (during screening tests) could become good hosts in the future with adaptation of the agents. Of course, conditions 1, 2 and 3 above must still be met before any damage to a non-target plant will occur.

One of the evening workshops addressed the question "Should we use agents that attack native and non-target plants?" In New this is almost a non question as any agent that attacked a native plant would be rejected for that reason. Because 80% of our native vascular plants are endemic we feel a strong desire to protect them, but it also means that problem weed species usually have no close relatives among the native flora. By contrast, some of the workshop participants were actively involved in controlling native species where they are agricultural weeds e.g. broom snakeweed (*Gutierrezia*) in US rangeland. If the workshop participants reached a consensus it was that it would be appropriate to introduce an agent that attacked native plants if (for a few of us, "but only if') there was a net economic or environmental benefit from so doing. One can imagine a situation where a weed is doing so much damage to a whole plant community that we would be prepared to accept some damage to one or two native species in order to return the whole community to a healthier state.

Issues that would need to be considered are:

How harmful is the weed?

What are the other control options?

What are the risks of biocontrol?

What are the benefits?

What are the likely effects on public relations and on the credibility of the biocontrol procedure in general, of releasing an agent that will attack native species?

Allied to this deliberate introduction of an agent that will attack non-target plants is the possibility of an agent moving to another country where it may become a problem. One example presented was that of South American phycitine moth (*Cactoblastis cactorum*) which was introduced into the West Indies in 1957 to control prickly pear (*Opuntia tricantha*). It has since spread naturally to several Caribbean Islands and now to Florida Keys where it poses a serious threat to endangered and rare *Opuntia* spp (including *O. tricantha*!). With the increased mobility in the world today this may become an increasing problem.

By contrast, a couple of papers discussed the possibility that agents may not be damaging enough on target plants. It appears, for example, that plants of leafy spurge (*Euphorbia esula*) in North America, where the species is a weed, may differ genetically from those in their continent of origin, Europe. These genetic differences may improve the species ability to defend itself against predators including those with which it naturally occurs thus thwarting classical biocontrol procedures of importing the native enemies. Another speaker hypothesised that over time weed species may lose their chemical defences against herbivores they are no longer subjected to and thus when a natural enemy is introduced as a biocontrol agent it may be more effective than back home.

It was interesting to have both points: too much damage from biocontrol agents or not enough, presented at the one symposium. As Harris (1988) has expressed it: "The proponents, as well as the opponents of biocontrol, generally credit prospective agents with far more punch than justified by the record". Only about a third of the insects introduced for weed control in Canada and the USA mainland consume substantial amounts of their host (Julien 1987). Of all biocontrol agents used only 35% have established in their new environments, and of these, only 60% have been of some economic or ecological benefit (Harris 1988). Further analyses of the most successful biocontrol projects can be found in Crawley (1989), Julien (1989) and Julien *et al.* (1984).

4. FUTURE RESEARCH

Various speakers at the symposium called for more research, specifically:

1. Study of agent-weed relationships in the host country.

2. Follow up studies on the success/failure of agent introductions.

It was argued that the results of follow up studies should be compared to those of ecological impact studies of the agent in its native country. This would improve our chances of selecting successful agents.

The value of long-term monitoring studies was also expounded; it is only with time that we know if it is "the bugs or the weather" that caused the decline in a weed. Likewise we should not be in a hurry with biocontrol; for example only after 15 years since its introduction has *Cactoblastis cactorum* become adapted and effected control on prickly pear (*Opuntia tricantha*) in South Africa. "The unexpected happens when you least expect it."

The call for more research was well matched by a particularly stimulating paper which reported on the New Zealand public's preparedness to pay for research into the biological control of old man's beard (*Clematis vitalba*). Because such research has no market value, the economic analysis of the costs and benefits of the research was based on expert opinion, but it was suggested that this was still a better basis for decision making than intuition. Incidentally, according to this study the New Zealand public is very willing to pay for research on biocontrol of old man's beard (Greer and Sheppard 1990).

5. APPROPRIATE PROCEDURES

Workshop discussion threw into sharp relief the pervading feeling among biocontrollers that they are the experts who should make the decisions on which weeds to control and which agents to import. The New Zealand approach is different. It involves several public consultation steps including a requirement for an environmental impact assessment to be prepared. At present New Zealand leads the field in this approach; it is to be hoped that other countries will follow.

In recent years integrated pest management has become fashionable in agriculture and it was mentioned at the symposium. It involves combining cultural practices such as fertiliser application and planting resistant varieties, with biocontrol and the judicious use of chemicals to about desired pest control. The concept, if not the details of the practice, can be applied to protected natural areas. They can be designed and managed to reduce weed invasion (Timmins and Williams 1990) and biocontrol can be used in conjunction with chemical control.

An intriguing paper described the control of the floating fern *Salvina molesta* in Botswana by biological control using an agent imported from Brazil (ex South Africa, ex Australia) plus draining the whole swamp land in which the weed occurred to prevent its dispersal on the backs of large mammals.

5.1 Consequences

At regular intervals during the conference people posed the question:

What happens after the target weed is controlled? This question could well be advanced at all other forms of weed control. The two answers seemed to be either:

1. Plant biodiversity will increase; the reduction in vigour of the weed would allow the return of species previously out competed by the dominant weed, or

2. Another weed will invade the site to take up the niche left vacant by the controlled weed; the native flora will still be kept at bay.

A clear message from the conference was that one must consider not only the ecological effects of biological control of a weed but also the ecological effects of no control, or of engaging in other forms of control such as chemicals. Biological control has the advantage, if successful, of effecting permanent control for low cost (over a long time) without the need for repeated visits to an area, which in themselves can be environmentally damaging.

6. IMPLICATIONS FOR CONSERVATION

While the first session of the conference was on biological control in protected natural areas, traditionally biocontrol of weeds has been mainly used in agriculture. Forty percent of the conference participants worked for agricultural or forestry institutions. Of the 44% who worked for government research organisations or universities, the majority were working on agricultural weed problems. Only 4% of the participants worked for a conservation organisation.

Concommitant with the emphasis on agriculture, historically economics has been an important factor in determining whether an agent should be released or not. For example, three species of foliage-feeding beetles (*Chrysolina* spp) were released in Canada to control St John's wort (*Hypericum perforatum*) on the grounds that the economic value of St John's wort as a weed was much greater than the economic value of the ornamental species of *Hypericum* which the beetles might also attack.

Nevertheless invasion by alien species is among the most serious threats to protected natural areas in New Zealand and elsewhere. Worldwide, biological control is being considered to combat this threat. The Hawaiian National Park weed control guidelines for example call for biocontrol in preference to the use of chemical pesticides (Gardner 1990). In fact this example illustrates a trend in philosophy rather than practice. In reality, often biocontrol is not adopted in Hawaii, as elsewhere, because of the lack of both infrastructure and immediacy of result. Added to these difficulties is the high initial cost of any biocontrol programme, despite the promised lower long-term cost (lower than other forms of control).

The symposium demonstrated that internationally there is a large resource of expertise, theoretical knowledge and technical skill that could be tapped by DOC should it choose to pursue biocontrol programmes. It showed there is potential for piggy-backing on other biocontrol programmes directed at species which are a problem here.

If the initial outlay for biocontrol programmes is high, the current costs for chemical control of DOC’s major problem weed species alone are prohibitive. Biological control of weeds is no panacea. It will neither solve every weed problem, nor can it effect eradication of weed species. What it *can* do is give us a fighting chance of successfully controlling a weed using chemical or mechanical means by first significantly reducing its vigour. Money spent on chemical control could well be significantly reduced and could be targeted to high priority areas.

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