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Conflict of Interest in Biological Control of Weeds in New Zealand

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Abstract

The role that conflicts of interest have played in the development of projects for biological control of weeds in New Zealand in the past is discussed. Particular reference is made to projects for control of blackberry (*Rubus fruticosus*), sweet briar (*Rosa rubiginosa*), manuka (*Leptospermum scoparium*) and gorse (*Ulex europaeus*). Our present policy and approach to resolving conflict situations is also discussed in the context of how weed species are selected as targets for biological control attempts.

Conflits d'Intérêts dans la Lutte Biologique Contre les Plantes Nuisibles en Nouvelle-Zélande

L'auteur examine le rôle qu'ont joué les conflits d'intérêts dans l'élaboration des projets de lutte biologique contre les plantes nuisibles en Nouvelle-Zélande dans le passé, en se référant plus particulièrement aux projets de lutte contre les ronces (*Rubus fruticosus*), l'églantier odorant (*Rosa rubiginosa*), le manuka (*Leptospermum scoparium*) et les ajoncs (*Ulex europaeus*). L'étude porte également sur les politiques et les méthodes actuelles de résolution des conflits relatifs à la méthode de sélection des espèces de plantes nuisibles cibles pour des tentatives de lutte biologique.

Introduction

Conflicts of interest were recognized from the outset when several projects aimed at tackling New Zealand's weed problems through biological control were initiated in the 1920s. Workers appreciated the necessity for reliable host-specificity data, and refrained from introducing insects when there was any danger of damage to non-target plants. In the case of gorse, *Ulex europaeus* L. (Leguminosae), recognition of its beneficial qualities caused prospective biological control agents to be restricted to flower- and seed-feeders. Most of the weeds which now cause serious problems in New Zealand were purposely introduced during the last century for their beneficial qualities, or to remind homesick settlers of Europe. Typically, under favourable climatic conditions, released from competitive pressure of other species and unrestrained by their native fauna, these weeds proved more aggressive than in their native range, growing faster and attaining greater size. Costs of weed control to agriculture and forestry in New Zealand are extremely high: Hill (1983*b*) calculated that for gorse alone, the current annual costs of control are in excess of $14 million.

In the past, biological control efforts have been directed against weeds whose control costs are greatest, but now that New Zealanders have developed a greater appreciation of their country's unique native flora, there are aesthetic as well as economic reasons for attacking introduced plants. Having suffered the consequences of well intentioned but unfortunate introductions of exotic species which have become pests, the public is understandably cautious of proposals to introduce further exotic organisms, beneficial or otherwise. Thus good publicity is essential to communicate the long-term advantages of biological control. To an environmentally conscious public, the concept of biological control is attractive. Apart from reducing the necessity for, and hence the cost of control by conventional means, the prospect of reduced dependence on ecologically damaging chemicals seems highly desirable.

However, we have to take care that our 'clients' are aware of the limitations of the biological method of control: that we aim only to reduce weed populations, not to eliminate them, that we cannot accurately predict the level of control tnat can be achieved, and that the time taken from the initiation of a project to its fulfillment may be lengthy. To justify the importation and release of a new insect species it is essential that results of specificity testing should be conclusive and convincing, to reassure those who are concerned about the potential danger to non-target plants. The public should be aware also of the safety record of our past work: none of the species introduced for weed control have been reported as damaging desirable plants. While cinnabar moth (*Tyria jacobaeae* L.) (Lepidoptera: Arctiidae) may (as indicated by host-specificity tests carried out prior to its release) occasionally be found on garden *Cineraria* spp. (Compositae), damage to the plant is insignificant.

Case Histories

We shall now consider several of the weed species for which biological control programmes have been undertaken, and the role that conflicts of interest have played in the development of these projects.

Blackberry: Rubus fruticosus *L. (Rosaceae)*

During the search for candidate insects for blackberry control, a review of the species recorded from this weed in other parts of the world was undertaken (Miller 1970). Insects attacking *Rubus* species in Hawaii, North America, Great Britain and Europe, and South Africa comprised 12 species of Hymenoptera, 6 species of Coleoptera, 12 species of Lepidoptera, 8 species of Diptera and 1 hemipteran. Unfortunately blackberry is closely related to a number of important crop plants, and most insect species recorded from *Rubus* were also recorded from cultivated plants. Between 1927 and 1931, however, consignments of five insect species attacking blackberry were imported into New Zealand (Miller 1970). Of these, two (from North America) were unable to be reared satisfactorily, and work with the remaining three (all from Europe) was discontinued when it was found they fed on economic plants.

Larvae of *Thyatira batis* (L.) (Lepidoptera: Thyatiridae) defoliated raspberry, loganberry and strawberry in tests under quarantine, while larvae of *Dasineura plicatrix* (H. Loew) (Diptera: Cecidomyiidae) attacked raspberry foliage. *Coraebus rubi* (L.) (Coleoptera: Buprestidae) was considered very promising since its stem-boring larvae were highly damaging to blackberry, but had only one other recorded host, the China rose, *Rosa indica* (Rosaceae). Nurserymen were consulted to ascertain that this species was not grown as a stock to any extent in New Zealand, but while tests showed that larval infestation did not occur on raspberry, loganberry or on four species of *Rosa*, adult beetles fed freely on a number of rosaceous crop plants. Thus release of this insect was ruled out, and work on biological control of blackberry was discontinued.

The redberry mite, *Acalitus essigi* (Hassan) (Acari: Eriophyidae), which causes redberry 'disease' in blackberries and raspberries first appeared in New Zealand in 1946

(Hamilton 1949). It was not introduced intentionally for control of blackberry, however, and Miller (1970) suggested that it may have arrived on apple stocks imported from England.

While in the interests of the country's berryfruit growers no further work on biological control of blackberry is planned in New Zealand, the Australians have been working with the European blackberry rust fungus, *Phragmidium volaceum* (C.F. Schultz.) Winter (Uredinales) (Hasan 1981). Since a rust fungus, once established in south-eastern Australia would be expected to reach New Zealand within a few years, New Zealand's interest in the project has been recognized. There has been regular contact between Australia and New Zealand throughout the project and it is unfortunate that, as the result of an apparently illegal introduction, the rust is now established widely in Victoria (Marks *et al.* 1984).

Sweet Briar: Rosa rubiginosa *L. (Rosaceae)*

Sweet briar was deliberately introduced into New Zealand by the early settlers, probably for decorative purposes, but its weedy properties had become apparent by 1900 when it was declared a noxious weed throughout the country (Molloy 1964). During the 1950s, following a spectacular decline in rabbit numbers, sweet briar became an increasingly aggressive scrub weed, particularly on dry tussock grassland country (Molloy 1966). Until the decline in rabbit numbers, grazing by rabbits and sheep checked growth of seedlings and young plants. No effective means of chemical control was immediately apparent (Dingwall 1962), and from 1962 the Commonwealth Institute of Biological Control investigated over 400 species of insect attacking sweet briar and its close relatives in Europe (Given 1967*a*). Few showed indications of being sufficiently specific, however. Not only is sweet briar closely related to horticultural crop plants such as apples, plums, apricots and raspberries, but cultivated varieties of *Rosa* are widely grown for gardens.

The most promising candidate for introduction was thought to be the gall wasp *Dipolepis rosae* (L.) (Hymenoptera: Cynipidae). It was anticipated that the National Rose Society would be concerned about its use, however, as the insect is not restricted to *R. rubiginosa*, but is recorded from a number of species of wild roses, as well as occurring occasionally on cultivated roses. It was observed that galls were much more numerous on roses growing under stress conditions where growth was slow, usually in areas with a warm, dry climate. Schroeder (1967) showed that *D. rosae* produced the greatest number of galls in localities with average summer temperatures above 18°C and less than 760 mm rainfall p.a. He suggested that cultivated roses, growing under good conditions, were able to suppress gall formation in almost all cases.

In 1968 it was decided to discontinue the sweet briar project since no highly effective and specific insect control agents had been found. A factor contributing to this decision was that no suitable quarantine facilities were at that time available in New Zealand to house the lengthy specificity testing programme that would have been essential prior to release of any insect.

The rose hip chalcid *Megastigmus aculeatus* (Swederus) is widespread on sweet briar throughout New Zealand (Molloy 1964). No assessment has been made of its effect on seed production here, although indications from its native Europe (Eichhorn 1963) are that infestation rates are low. It is unfortunate that none of the five species of insect studied in rose hips in Europe showed signs of being very effective (Eichhorn 1963), since growers of cultivated roses are unlikely to be so concerned about seed feeders.

Manuka: Leptospermum scoparium *Forst. (Myrtaceae)*

During the 1940s large areas of the native scrubweed, manuka, were dying as a result of attack by the scale insect *Eriococcus orariensis* Hoy (Homoptera: Eriococcidae). This species, and the closely related *E. leptospermi* Maskell are thought to have been self-introduced from Australia, windborne across the Tasman sea (Hoy 1959). Farmers, keen to utilize an organism which might destroy what was to them a troublesome woody weed, actively transferred infected material from original infestation sites in Canterbury to other parts of the country so that by 1954 the scale insect was widely distributed on manuka through both North and South islands of New Zealand (Hoy 1954). Hoy (1949) observed that although the scale insect was capable of killing stands of manuka, this was a gradual process taking 6–7 yrs from the time of initial infestation. Given (1967*a, b*) noted that although the scale was spectacularly effective in controlling manuka for some years, it apparently became less effective. This loss of influence was attributed to the insect pathogenic fungus *Myrangium thwaitesi* (Dothideales).

Hoy (1953) remarked that there was considerable controversy regarding the wisdom of using a biological control agent against a substantial member of the indigenous flora. Manuka plays a significant role in natural regeneration of native forest and is also important in preventing erosion on steep hill country, as well as providing good firewood and a measure of shelter for stock (Hoy 1949). During a survey in south-eastern Australia and Tasmania, Hoy (1959) discovered that there was at least one other species of *Eriococcus* which, should it be introduced into New Zealand, could result in even greater damage to manuka. But because of reservations concerning the merits of manuka as against its weedy properties, no introductions were considered.

Gorse: Ulex europaeus *L. (Leguminosae)*

Gorse was purposely introduced into New Zealand last century as an inexpensive and fast-growing hedging plant, but spread rapidly throughout the country to be declared a noxious weed in 1900 (MacCarter and Gaynor 1980). When insects were considered for gorse control in the 1920s, gorse was still recognized as a valuable shrub for fencing, shelter and even fodder (Miller 1970), so the search in Europe was confined to those species which attacked flowers and seeds. Thus it was hoped to contain the spread of the weed without interfering with its growth in situations where it was considered beneficial. Of the usable species discovered which were restricted to gorse, the most information was available on the gorse seed weevil, *Apion ulicis* Forst. (Coleoptera: Apionidae). The gorse seed weevil was introduced in 1926 and it established well to become one of the most common insects in New Zealand (MacCarter and Gaynor 1980). Its effect on seed production is not known, but while Miller (1970) suggests that there may be two generations/yr under New Zealand conditions, Cowley (1983) has found that around Auckland, at least, there is only one generation/yr, and that the winter crop of seeds (from February to May) is unattacked by the weevil. *A. ulicis* is parasitized by a *Pteromalus* sp. (Hymenoptera: Pteromalidae) of unknown origin (P. Syrett, unpubl. data).

The current situation is that while it has been shown that gorse can be useful as a pioneer species in the regeneration of native vegetation (Hackwell 1980), and is still used to a very limited extent for hedging and shelter, it is considered to be one of the worst and most costly weeds of agriculture and forestry (Hill 1983*b*). Thus Entomology Division, DSIR, has renewed its efforts towards biological control of gorse. Several species are under consideration for introduction (Hill 1983*a*).

In response to active publicity for this work by the DSIR, New Zealand beekeepers have expressed concern that biological control of gorse will result in the loss of a valuable pollen source. To counter this fear, we were represented at the 1983 New Zealand Beekeepers Conference (Hill 1983*b*). Hill made it clear that, with the maximum level of control likely to be achieved, gorse would still remain a common plant, and that it was even less likely to experience temporary removal from local areas than by current conventional control measures.

Concern has also been expressed about the possible use of the gorse mite, *Tetranychus lintearius* Dufour. (Acari: Tetranychidae), for control of gorse. While this mite is the only species known to kill gorse bushes (Hill 1983*a*) it is a close relative of the two-spotted mite, *T. urticae* Koch, a serious pest of horitcultural crops (Scott 1984). Thus in addition to exhaustive host-specificity testing, it is necessary to ensure that the gorse mite will not hybridize with *T. urticae*, since the introgression of gorse mite genetic material into New Zealand populations of the pest mite (with the possibility of improved performance of the pest mite) would be regarded as potentially damaging. These studies are currently in progress at CIBC, U.K. (R.L. Hill, unpubl. data).

Discussion

Nearly 60 yrs after the inauguration of biological control of New Zealand weeds by means of insects we have still to resolve the problem of how best to allocate our resources and which weeds we should work on in the future. While we are committed to our present projects, we should clarify the principles on which future projects will be selected. Currently the weeds we have selected to work on are those whose control costs by conventional means are high, and which cause serious problems throughout the country. We are aware of the limitations of these criteria, but true economic costs of a weed and the economic gains through biological control are extremely difficult to obtain. To justify allocation of further resources for biological control work it is necessary that success be demonstrated. New Zealand's early projects on biological control of weeds illustrate the limitations imposed by conflict of interest: both the blackberry and sweet briar programmes were concluded without the release of a single insect, following the investment of many years' work. Scientifically such work may not be wasted, however. With the passage of time, changing interests may even lead to the removal of the conflict and projects being reactivated. Practically, however, the public looks for results, and since conflict of interest imposes such limitations on our work, it is an important factor to be considered when new projects are contemplated.

Conflicts may be divided into three classes: (*a*) those where the weed status of the target plant is in question; (*b*) those where the conflict arises through the risk to non-target plants; and (*c*) those relating to programmes against native weeds where ecological and conservation aspects are important. There has been some slight conflict over our thistle control programme. Insects have been released against nodding thistle (*Carduus nutans* L.; Compositae) and Californian thistle (*Cirsium arvense* [L.] Scop.; Compositae) (Jessep 1975, 1981; Jessep unpubl. data). Neither thistle species is closely related to any economic plant grown in New Zealand, and there are no native species of either genus in New Zealand. However beekeepers have expressed concern about nodding thistle which they regard as a valuable source of nectar; since *C. nutans* is classified as a noxious plant, and is presently controlled by chemical means, Hill (1983*b*) has pointed out that nectar production (from thistles and clovers) is more likely to be reduced by the current applications of herbicide to pastures than by developing biological controls.

Other weed species which have recently been brought to our attention as candidates for future biological control programmes are old man's beard (*Clematis vitalba* L.; Ranunculaceae) and hawkweeds. *C. vitalba* is a serious problem in native bush reserves where it smothers and kills trees (Atkinson 1984). It is difficult to control with herbicide without damaging native vegetation, so that current control measures are highly labour intensive. Biological control is thus an attractive option, but any prospective control agent must be specific to *C. vitalba* and not attack the 11 native *Clematis* species. In addition, ornamental species are cultivated in many gardens. Thus conflicts could arise concerning the risk to non-target plants. Hawkweeds (*Pilosella* spp. and *Hieracium* spp.; Compositae) are weeds of hill and high country pasture with allelopathic properties (Makepeace 1976) and no beneficial qualities of consequence. Their taxonomy is complex, but they have no close relatives among cultivated plants nor among plants native to New Zealand. A number of rust fungi are recorded from *Pilosella* spp. and literature records show 16 species of insect occurring on hawkweeds (Scott, pers. comm.).

It is not always possible to anticipate conflicts which may arise, at the outset of a project. A plant recently added to the list of eocnomic species in New Zealand is tree lucerne, *Chaemaecytisus palmensis* (comb. ined.) (Leguminosae). Tree lucerne is being developed for hedging, is useful for shelter, forage and as a source of nectar for bees (Davies and MacFarlane 1979). This has implications for our biological control programmes against gorse and broom (*Cytisus scoparius* [L.] Link; Leguminosae) since preliminary work shows that insects otherwise specific to gorse and broom (Waloff 1968) may find tree lucerne a suitable alternative host (R.L. Hill, unpubl. data).

Native weeds have been included as candidates for biological control projects in the past. For example the sawfly *Ucona acaenae* Smith (Hymenoptera: Tenthridinidae) (previously *Antholcus varinervis* Spinola) was introduced from Chile for control of piripiri (*Acaena* spp.; Rosaceae) (Miller 1970). Its larvae cause severe damage to leaves and developing flowers. Releases were made from 1936 onwards. Initially it established well, having a marked effect on the weed, but after a few years it apparently died out. However our present policy is to concentrate our efforts towards control of exotic weed species. Before attempting to manipulate a member of the indigenous flora it is important that its ecological role be thoroughly understood; this information is not readily available for many native weeds.

Biological control is generally a long-term approach to weed control, and since our resources are very limited, it would seem most profitable to work in areas where there is a high chance of success. There are a number of factors to be considered here, but one should be to avoid any project in which a strong conflict of interest is apparent at an early stage. The Ministry of Agriculture and Fisheries (MAF) controls the introduction of new species into New Zealand. At the time an application is made to MAF as the regulating body, the destiny of each organism must be specified. This provides an early opportunity for potential conflicts to be recognized. When conflicts do arise, it is desirable that interested parties be brought together so that some balance may be achieved between the conflicting factors. While responsibility rests with us to ensure that people are aware of our work and its implications, at least some of the onus for justification of biological control projects should rest on the parties which benefit from the introductions.

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