INSECTS FOR BIOLOGICAL CONTROL OF BROOM (*CYTISUS SCOPARIUS*) IN NEW ZEALAND

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Summary A program to introduce insects for biological control of broom (*Cytisus scoparius*) in New Zealand began in 1981. The twig mining moth *Leucoptera spartifoliella* was already well established: its means and time of arrival in New Zealand from its native Europe are unknown. This moth has a substantial impact on broom but the weed is still a serious problem in pastures, plantation forests, river beds, and some conservation areas. Broom is still invading new areas in New Zealand. Broom seed beetle, *Bruchidius villosus*, was first released in 1987, and the broom psyllid, *Arytainilla spartiophila*, in 1993. Both have established. Tests of host specificity are almost completed for the leaf-feeding beetle *Gonioctena olivacea*, the foliage-feeding caterpillars *Agonopterix assimilella* and *Chesias legatella*, and the root-feeding weevil, *Sitona regensteinensis*.

INTRODUCTION

Broom (*Cytisus scoparius* (L.) Link) was first recorded in New Zealand in 1872 (Webb *et al.* 1988) and occurs predominantly on the eastern sides of both islands, from Northland to Southland. It occupies open habitats, both on productive and conservation lands, and although widespread and abundant, continues to invade new areas. Broom is found from sea level to 1200 m (Stevens and Hughes 1973). Establishment costs of exotic pine forests are increased by the need to clear broom from plantation sites, and re-invasion by the weed reduces the rate of tree growth (Balneaves personal communication). Broom is a serious invader of pastoral land, particularly in the drier hill country areas, where substantial losses to agricultural production may result (Bascand and Jowett 1982). Habitat of nesting native birds on open river beds is threatened when broom and other scrub weeds invade and provide cover for predatory species (Hughey 1985). In some situations broom can be contained by grazing management, and where further control is necessary, herbicides, although expensive, are effective (Balneaves 1982). Cutting and burning have also been recommended in certain situations (Anon. 1981).

Broom is a suitable target for biological control because of the high costs of alternative control measures (relative to the economic returns from much of the marginal lands on which broom grows) and its widespread distribution in New Zealand. Broom has a large fauna in its native Europe and a high proportion of specialized insects that are restricted to broom and its close relatives. Thus prospects for identifying potential control agents are good.

A biological control program for broom in New Zealand was initiated in 1981 by the Department of Scientific and Industrial Research (DSIR), and is currently continuing under Manaaki Whenua – Landcare Research. Work is being carried out in collaboration with the International Institute of Biological Control (IIBC) in the United Kingdom. We co-operate with CSIRO and the NSW Department of Agriculture who are now working on a parallel program on biological control of broom in collaboration with IIBC. International collaboration has increased further through the renewed interest in broom in the United States. Participants from Europe, New Zealand, and Australia, as well as from North America, attended a Broom Symposium in Portland, Oregon in April 1996.

Our goals have been to identify and introduce host-specific insects to reduce the rate of growth and reproduction of broom, to reduce its competitive ability, and to slow its rate of invasion. Ultimately, achievement of these goals will reduce the problem status of broom and the costs of its control by conventional methods. The studies on potential biological control agents, preparation of Importation Impact Assessments (IIAs), and evaluation studies are being funded by the Foundation for Research, Science, and Technology (FRST), while Regional Councils, the Department of Conservation, Landcorp, and farmer groups have contributed towards rearing, release, and establishment of control agents.

EXISTING INSECT FAUNA

At the beginning of the biological control program a survey of insects occurring on broom throughout New Zealand was conducted (Syrett 1993). Species diversity and the overall numbers of insects recorded were low compared with the fauna of broom in Europe. However, one specialized broom-feeding insect, the twig mining moth *Leucoptera spartifoliella* Hübner (Lepidoptera: Elachistidae), was common and widespread throughout New Zealand (Syrett and Harman 1995). It is not known how it became established here, but the first specimen collected is dated 1950. This moth frequently occurs at damaging population levels, an event that is rare in its native Europe. It is thought that the difference may be

caused by the presence in Europe of parasitoids, in particular the moth's most common larval parasitoid, *Tetrastichus evonymellae* (Bouché) (Hymenoptera: Eulophidae). No parasitoids have been found attacking *L. spartifoliella* in New Zealand (Scheele and Syrett 1987). Studies are in progress to quantify its impact.

Several generalist insects occasionally damage broom in New Zealand. Caterpillars of both native and introduced tortricid moths web together young twigs and feed externally on broom foliage causing significant damage. The cerambycid *Oemona hirta* (F.) can cause substantial damage to thicker stems, causing death of large branches. It has a broad host range including many economically important species (Penman 1984). A stem-boring caterpillar, *Anisoplaca ptyoptera* Meyrick (Lepidoptera: Gelichiidae), is sometimes found girdling stems of broom, and can cause the death of large branches, or even whole bushes. However, it is found more commonly on gorse (*Ulex europaeus*), and is thought to have transferred to the two exotic hosts from native *Carmichaelia* species (Holder 1990).

INSECT INTRODUCTIONS

Two insect species have been introduced into New Zealand as biological control agents for broom, the seed-feeding beetle, *Bruchidius villosus* (F.) in 1987, and the psyllid, *Arytainilla spartiophila* (Forster) in 1993 (Harman *et al.* in press). A stem-mining weevil, *Perapion immune* Kirby, was identified as having excellent potential as a biological control agent because it caused substantial structural damage to plants by mining stems, which then broke at the nodes. It is multivoltine, so has the potential to reach high population levels. Host specificity tests were completed but the weevil has not been released because it has the potential to damage an important native legume, *Sophora microphylla* Aiton (Syrett *et al.* 1995).

Adults of *B. villosus* are pollen feeders, but their larvae feed and develop inside individual broom seeds, destroying them. Host specificity tests showed that development of *B. villosus* was restricted to *Cytisus* species, and possibly to *C. scoparius,* and that it posed no threat to non-target species (Syrett and O'Donnell 1987). Releases of 1000 beetles have been made at each of 48 sites throughout New Zealand. Beetles have established at six of 10 of the sites where releases were made in 1992–93 or earlier. At a site in Lincoln, Canterbury, where beetles were first released in 1991, the rate of infestation of seeds by beetles rose from 5% three years after release to 20% four years after release. Parasitism is a primary source of mortality of beetles in Europe (Parnell 1964), but so far levels of parasitism have been low in New Zealand. We do not know at what population level the broom seed beetle will stabilize. Even if it is not high enough to reduce the seed bank under existing broom stands sufficiently to affect their replacement, it may slow the rate of spread of broom into new areas (Hosking 1995).

Of the two species of psyllid feeding on broom in the United Kingdom, *Arytainilla spartiophila* and *Arytaina genistae* Latreille, *A. spartiophila* was chosen for introduction because of its narrower host range, and observed damage to broom in Europe. Its eggs are laid in green stems in summer, and overwinter in this stage. Larvae emerge early in spring, to develop into a new generation of adult psyllids. Populations can reach high levels, causing severe damage to broom bushes. Host specificity tests for the broom psyllid were completed in 1990 and an IIA was prepared. The broom psyllid has been released at 20 sites throughout New Zealand. Establishment has been confirmed at one site near Lincoln, but for most of the releases (five made in 1994, and 14 in 1995), it is too soon to confirm establishment. Further releases of both these insects throughout New Zealand are planned under a co-operative program with Regional Councils, the Department of Conservation, Landcorp, forestry companies, and a farmer group.

PROSPECTS FOR FURTHER INTRODUCTIONS

The fauna of broom in the United Kingdom has been well studied and includes a number of specialized insects feeding on the plant (Waloff 1968). Host testing is almost complete for a broom leaf beetle, *Gonioctena olivacea* (Forster), that is numerous and widespread in Europe and particularly damaging to seedling plants. Results of host specificity tests indicate that there may be some risk of damage to tree lucerne, *Chamaecytisus palmensis* (Christ) Bisby et K. Nicholls (Wapshere and Hosking 1993), and this issue will be addressed in the IIA to be prepared shortly. Testing for host specificity of a weevil that feeds on root nodules of broom, *Sitona regensteinensis* Herbst and two foliage-feeding caterpillars, *Chesias legatella* (Denis & Schiffermüller) and *Agonopterix assimilella* (Treitschke), should be completed by June 1997. Most tests with these species have been carried out for New Zealand by the IIBC at Silwood Park in southern England.

There are a substantial number of further species with potential for biological control, including some that either occur in south-west Europe but not in the United Kingdom, or are more common further south. South-west Europe is the centre of origin of *Cytisus* spp., so the greatest diversity of insect species on broom occurs here resulting in an increased number of specialists (Syrett *et al.* in press). Prioritizing species for future consideration will be important.

CONCLUSIONS

The New Zealand biological control of broom program has proceeded relatively slowly since its inception in 1981, but one specialized broom insect, *L. spartifoliella*, is already widely established and causing damage. Since broom is a vigorous and aggressive weed that thrives in a range of habitats and is continuing to expand its range, it is likely that a number of complementary agents will be required to meet our management goals for broom. Of the two insects that we have already established, *B. villosus* attacks broom seeds, and has the potential to slow the rate of spread of broom into new areas, even if it does not reduce the seed bank sufficiently to influence the replacement of existing broom stands. The other, *A. spartiophila*, can be damaging to broom both in Europe and in Oregon, USA. Four more species may be cleared for release shortly. There are further potential insect control agents available, particularly from south-west Europe, and these will be prioritized for further study.

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