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The Biological Control Program Against Gorse in New Zealand

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Abstract

Gorse (*Ulex europaeus* L.: Fabaceae) has been a serious weed in New Zealand for over 100 yr, and continues to invade pastoral land, forest plantations, and vulnerable natural habitats. It has beneficial uses, but these are far outweighed by the costs. Gorse was once an important hedge plant, and until 1982, seed-feeding insects were the only biological controls considered appropriate. *Exapion ulicis* Forst. was released in 1931, and destroys about 35% of the annual seed crop. Six control agents have been introduced since 1988. *Cydia succedana* (Dennis and Schiffermüller) was released in 1992. Assessment at 1 site shows that the 2 seed-feeding insects can destroy about 90% of the annual seed crop. Gorse spider mite (*Tetranychus lintearius* Dufour) was introduced from several sources in Europe in 1989 and 1990, and established widely. Mite outbreaks severely damage plants, and reduce flowering, but populations large enough to kill mature gorse plants over wide areas cannot be sustained, probably because of predation. The gorse thrips, *Sericothrips staphylinus* Haliday, was introduced in 1990. It has spread only slowly, but significantly damaged gorse foliage in experimental studies. The foliage-feeding moths *Agonopterix ulicetella* (Stainton) and *Pempelia genistella* (Duponchel) have been released. Establishment is not yet certain. The scythridid moth, *Scythris grandipennis* (Haworth), has also been released, but it did not establish. No further releases are planned. Development of a bioherbicide augments the classical approach to biological control of gorse. The paper discusses the impact of control agents, and the future of the research. The New Zealand program has provided information and control agents to similar programs in Hawaii, Oregon and California, Chile, and Australia.

Keywords: Gorse, *Ulex europaeus*, New Zealand, seed

Introduction

Gorse (*Ulex europaeus* L.: Fabaceae) is a spiny shrub that can form fast growing impenetrable thickets up to 4 m tall in New Zealand. Even-aged stands can live up to 29 yr (Lee *et al.* 1986). Plants can produce 34,000 seeds per m^{-2} per annum (unpublished data), and the seeds can be long-lived in the soil (Hill *et al.* 1999). Gorse is highly invasive. Blaschke *et al.* (1981) recorded it in varying densities on 700,000 ha of New Zealand. This is approximately 5% of the land area not occupied by indigenous forest, or alpine or sub-alpine vegetation. It covers land suitable for agriculture. It shades out tree seedlings in new plantation forests, and then reduces growth of surviving trees, and invades vulnerable natural habitats. Gorse is combustible, and increases the fire risk in forests and peri-urban areas.

Gorse was introduced to New Zealand as a hedge plant before 1838, and ribbons of

3rd

potential weeds were soon established across the landscape. Gorse spread quickly, and by 1900 it was declared a weed by Act of Parliament. Nevertheless, live gorse fences continued to play a crucial role in New Zealand's agricultural development for another 50 yr, until most were replaced by posts and wire. This created the paradox of an acknowledged weed that was also of significant agricultural value, and conflicting attitudes about gorse influenced the direction of biological control research until 1988. The extensive literature concerning the biology, ecology, economics, and control of gorse has been reviewed comprehensively by MacCarter and Gaynor (1980), Gaynor and MacCarter (1981), and more recently by Richardson and Hill (1998).

The first attempt to control gorse biologically was one of the earliest undertaken worldwide. The value of gorse as an inexpensive live fence, and shelter plant was taken into account, and the initial search for agents in Europe was restricted to those insects that damaged flower buds, flowers, and pods (Miller 1970). Davies (1928) recorded that 92% of the pods that he examined in England were infested with gorse seed weevil *Apion ulicis* Forster, and recommended this species as a control agent. The weevil was duly imported into New Zealand in 1928, and was widely released from 1931 to 1947. Soon the proportion of pods infested in spring approached the levels observed in England by Davies, and Miller (1970) intimated that successful control was expected. However, the high levels of pod infestation recorded were misleading. Gorse can form seeds in both spring and autumn, while *E. ulicis* is only active in spring. Later studies have revealed that where the bulk of annual seed production is in autumn, infestation of the small number of pods formed in spring often exceeds 90%. However, where most seed develops in spring, production swamps the weevil, and the rate of seed destruction is lower (Hill *et al.* 1991a). Cowley (1983) found that although infestation of pods in spring was high in the area she studied, seed weevil only reduced the annual seed crop by about 35%. Markin and Yoshioka (1996) observed that feeding by adult *E. ulicis* caused significant damage to gorse foliage.

Chater (1931) noted at least 5 insects that fed on reproductive structures on gorse, but no further agents were introduced at that time, possibly because of the apparent success of the weevil. Later, the use of phenoxy herbicides, and management by fire were considered the best solutions to the gorse problem (Gaynor and MacCarter 1981). Zwölfer (1962) completed a comprehensive review of the phytophagous fauna of gorse in Europe, and evaluated the potential of each one as a biological control agent (Schroeder and Zwölfer 1970). However, it was not until 1978 that biological control was considered once more. MacCarter and Gaynor (1980) reviewed all of the information available about gorse in New Zealand, the insects that attack it there, and the biological control options available in Europe. Hill (1982) studied some of the relationships between gorse and its fauna in Europe, and in collaboration with CABI Bioscience, host-range testing of several agents in Europe began in 1980. The program was stalled in 1982 by a public debate about whether the potential benefits that would accrue to New Zealand agriculture from biological control of gorse outweighed the potential costs. Apart from its (declining) value as a hedge, gorse was seen as a source of pollen for bees, and a forage plant for the burgeoning goat-farming industry (Richardson and Hill 1998). Most importantly, some ecologists and environmentalists feared that biological control would have an adverse effect on the role of gorse as a nurse-plant for the restoration of native vegetation on much abandoned agricultural land (Hill and Sandrey 1986, Wilson 1994). After extensive public consultation, and independent assessment of the assembled information (Hill 1987, Hill 1990),