IMPORTATION BIOLOGICAL CONTROL OF *HELIOTHRIPS HAEMORRHOIDALIS* BY *THRIPOBIUS SEMILUTEUS* IN NEW ZEALAND–A CASE STUDY OF NON-TARGET HOST AND ENVIRONMENTAL RISK ASSESSMENT

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INTRODUCTION

This paper presents a case study of the introduction of a new biological control agent into New Zealand and gives an overview of the information required to apply for release to the Environmental Risk Management Authority (ERMA). *Heliothrips haemorrhoidalis* Bouché (greenhouse thrips) (Thysanoptera: Thripidae) was first recorded in New Zealand in 1930 and is an exotic pest that damages citrus, avocados and ornamental plants (Mound and Walker, 1982). The citrus and avocado industries have estimated that *H. haemorrhoidalis* costs New Zealand $6.25 million per annum (U.S.$2.6 million) in fruit rejected for export and in insecticide use, which equates to 9.5% of their combined domestic and export earnings. Research into the control of *H. haemorrhoidalis* in New Zealand showed that there was a range of generalist predators feeding on *H. haemorrhoidalis*; however, no effective natural enemies were found (Steven, unpub.). A biological control agent, *Thripobius semiluteus* Boucek (Hymenoptera: Eulophidae), was identified to be the most effective and host specific parasitoid from research in Australia and California (U.S.A.) (McMurtry, 1988, 1992; Beattie and Jiang, 1990). *Thripobius semiluteus* has now been released into New Zealand to control *H. haemorrhoidalis*. Before its release in New Zealand, an extensive research program spanning six years was carried out to provide evidence of nil or negligible environmental impacts (on New Zealand's flora, fauna, environment, and indigenous culture), and to determine the host-specificity of *T. semiluteus* as required under New Zealand's strict new Biosecurity Laws.

Host records from India, Australia, Africa, North America, and South America suggested that *T. semiluteus* only parasitizes thrips within the subfamily Panchaetothripinae. Of five recorded hosts for *T. semiluteus* (LaSalle and McMurtry, 1989; Loomans and van Lenteren, 1995), only *H. haemorrhoidalis* is present in New Zealand. There are three other members of the Panchaetothripinae in New Zealand–the endemic species *Sigmothrips aotearoana* Ward, the exotic banana-silvering thrips (*Hercinothrips bicinctus* Bagnall), and the exotic palm thrips (*Parthenothrips dracaenae* Heeger), the last two of which are either pests or potential pests in New Zealand (Mound and Walker, 1982). The possible impacts of *T. semiluteus* on *S. aotearoana* became the primary focus for evaluating non-target effects.

This paper provides an overview of the information needed to apply for the release of a new biological control agent in New Zealand (see also Charles, 2001).

METHODS

Detailed methodologies for all the information in this overview can be obtained from the references listed. The research programme was broken into two major components:

1. Ecological and biological studies of *S. aotearoana*, *H. haemorrhoidalis,* and *T. semiluteus*. These included determining the current or potential distribution, habitat, and population dynamics of *T. semiluteus*, *H. haemorrhoidalis,* and *S. aotearoana* (Froud, 1997; Froud and Stevens, 1997).

2. Determining the host specificity of *T. semiluteus* against non-target species by conducting choice and no-choice experiments (Froud *et al*., 1996; Froud and Stevens, 1998).

RESULTS AND DISCUSSION

Ecological and Biological Factors

The distribution of *S. aotearoana* in New Zealand is more extensive than that of *H. haemorrhoidalis* and includes a population in Southland (46° S, 169° E) (Mound and Walker, 1982) that is well beyond the potential range of both *H. haemorrhoidalis* and *T. semiluteus* (43° S, 172° E) (Froud and Stevens, 1997). *Heliothrips haemorrhoidalis* and *S. aotearoana* also live in different habitats; *H. haemorrhoidalis* is most often found in urban, horticultural and modified environments and rarely occurs in native forest, where *S. aotearoana* is found. Habitat separation between the two thrips species should decrease the chances of *S. aotearoana* being encountered by *T. semiluteus*.

Sigmothrips aotearoana appears to overwinter as adults (no larvae have been recorded between late June and late October) while all life stages of *H. haemorrhoidalis* are present throughout the year (Froud, unpub.). *Sigmothrips aotearoana* overwintering requirements would reduce the ability of *T. semiluteus* (which is predicted to remain active all year) to form self-sustained populations on *S. aotearoana,* as no larvae are available for parasitism for 4 to 6 months of each year.

Thripobius semiluteus is a koinobiont parasitoid, a group which is considered to be more host-specific than the idiobionts (Askew and Shaw, 1986). This life history strategy of *T. semiluteus* should reinforce the probability of a limited host range and restrict *T. semiluteus* from adapting to *S. aotearoana*.

Host Specificity Experiments

Thripobius semiluteus was imported into a quarantine facility to undertake host specificity testing of *T. semiluteus* with *S. aotearoana*. Experiments demonstrated that *T. semiluteus* can parasitize and complete its development in *S. aotearoana*. However, when *T. semiluteus* was offered a choice between *S. aotearoana* and *H. haemorrhoidalis*, significantly more *H. haemorrhoidalis* were parasitized (90.4% compared with 8.8% for *S. aotearoana*) ($P < 0.05$) (Froud *et al*., 1996). In no-choice tests, a few *S. aotearoana* were also parasitized (6.8% compared with 92.8% for *H. haemorrhoidalis*). The number of parasitized *S. aotearoana* was not affected by the presence or absence of the preferred host species *H. haemorrhoidalis*, suggesting that *T. semiluteus* would not attack significant numbers of *S. aotearoana* in the field. Additionally, the percentage of parasitoids successfully completing development on *S. aotearoana* was 52.7%, significantly lower ($P < 0.05$) than the percentage developing on *H. haemorrhoidalis* (95.3%), indicating that *S. aotearoana* is not as suitable a host.

Exposing the closely related *Hercinothrips bicinctus* to *T. semiluteus* under the same laboratory conditions and experimental methods assessed the possibility that the low level of parasitism of *S. aotearoana* was an artifact of confinement. *Hercinothrips bicinctus* is present in both New Zealand and Australia. In Australia it is sympatric with both *T. semiluteus* and *H. haemorrhoidalis,* but has not been recorded as a host for *T. semiluteus*. In no-choice tests, *T. semiluteus* parasitized *H. haemorrhoidalis* and *H. bicinctus* equally ($P > 0.05$) (47.6% and 33.6%, respectively). In choice tests, *T. semiluteus* parasitized significantly more *H. haemorrhoidalis* than *H. bicinctus* (46.2% and 5.8%, respectively) ($P < 0.05$). Equal numbers of parasitoids completed development in both hosts in both tests. Parasitism of *H. haemorrhoidalis* and *H. bicinctus* was higher than that of *S. aotearoana* on all occasions (Froud and Stevens, 1998). Parasitism of *H. haemorrhoidalis* was higher in the tests with *S. aotearoana* (90.4% and 92.8%) than in the tests with *H. bicinctus* (46.2% and 47.6%). This may have been due to a drop in the fitness of the parasitoids over a prolonged period of rearing in captivity, as there was an 8-

month gap between the two experiments. That *T. semiluteus* parasitizes *H. bicinctus* in quarantine, but has never been recorded from this host in the wild, supports the hypothesis that the low parasitism of *S. aotearoana* was due to the effects of confinement, and thus are not predictive of parasitism under natural conditions. This hypothesis is reinforced by laboratory host records of *T. semiluteus* from *Hercinothrips femoralis* Reuter (Thysanoptera: Thripidae) in the United States, a species that has never been found to be used as a host in the field (Loomans and van Lenteren, 1995).

Further Requirements

In addition to the research outlined above, a full cost-benefit analysis was conducted and public consultation was undertaken with all interested parties, which included governmental research bodies, environmental groups, and the Tangata Whenua (indigenous people) of New Zealand. New Zealand's Environmental Risk Management Authority (ERMA) received eight submissions from concerned parties covering a range of issues including (1) environmental concerns–the possible risk to *S. aotearoana* and the risk of parasitoid interbreeding with other invertebrates; (2) cultural concerns–adequacy of consultation and the release of any exotic species; and (3) potential benefits–benefit to the citrus and avocado industries and reduced sprays in the environment.

A formal court hearing was held, with four submitting parties wishing to be heard (the New Zealand Department of Conservation, Royal Forest and Bird Protection Society, New Zealand Avocado Industry Council, and New Zealand Citrus Growers Inc.). The public hearing focused on the balance between the potential benefits to horticultural exports and the environment through reduced use of sprays with the demonstrated small risk of *T. semiluteus* to *S. aotearoana*.

CONCLUSIONS

Permission to release *T. semiluteus* was issued by ERMA following the public hearing. Application was then made to the Ministry of Agriculture and Forestry (MAF) to import *T. semiluteus* into quarantine, where voucher specimens were taken and pathology and hyper-parasitoid checks were made. A further application was then made to MAF to release *T. semiluteus* from quarantine and ERMA was advised. A letter was also sent to all Iwi (regional groups of the indigenous people of New Zealand) advising of the release of *T. semiluteus* into their region.

The first releases were made in February 2001 and *T. semiluteus* was recovered from the first release site in March 2002, indicating that *T. semiluteus* has locally established and has survived its first winter in New Zealand.

ACKNOWLEDGMENTS

The authors acknowledge the contribution towards this research by the New Zealand Foundation for Science Research and Technology and the citrus and avocado industries.

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