QUARANTINE HOST RANGE TESTS ON TWO EXOTIC PARASITOIDS IMPORTED FOR APHID CONTROL

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SUMMARY

Two parasitoids were imported into quarantine facilities at Lincoln, New Zealand. *Aphidius sonchi* (Hymenoptera: Aphidiidae) was imported from Australia as a potential biological control agent against the sowthistle aphid (*Hyperomyzus lactucae*), a pest of blackcurrants and lettuce. *Ephedrus cerasicola* (Hymenoptera: Aphidiidae) was imported from Norway as a potential agent against the green peach aphid (*Myzus persicae*), a virus vector on many crops. The rate of parasitism of 17-20 aphid species was determined in caged tests of aphids exposed to each parasitoid. *E. cerasicola* parasitised five New Zealand native aphids, and was not released, whereas *A. sonchi* did not attack any native aphid species nor their close relatives. Release of this parasitoid was approved.

Keywords: biological control, aphids, quarantine testing, parasitoids

INTRODUCTION

Introductions of biological control agents into New Zealand are subject to permit under the Animals Amendment Act (1990). Among factors to be considered in permitting the importation of an exotic animal species, the Minister of Agriculture and Fisheries or his delegate must consider "any other possible harmful effects that the establishment in New Zealand of animals of that species might have on natural resources", where the latter include "plants and animals of all kinds". In practice, an importer of an exotic parasitoid of an insect pest must show that any possibly harmful effects on native insects are negligible. The evidence produced is evaluated by staff of MAF Regulatory Authority, assisted by a panel of consultants.

There is little scientific evidence to guide the evaluation of risk to native insects posed by the introduction of exotic parasitoids of introduced insect pests, and opinion on the extent of the risk is divided (eg. Po-Yung Lai 1988). There is an increasing requirement for exotic agents to be host-specific or oligophagous (Goldson *et al.* 1994), but the extent to which they attack native insects can only be studied in quarantine. The results of these studies may be in part dependant on the effect of caging on the parasitoid host range (Sands 1993), and their relevance to parasitoid behaviour in the field is unknown. The decision on whether to release the parasitoid into the New Zealand environment is therefore a matter of judgement based on limited evidence. This paper describes the risk-assessment process for two aphid parasitoids imported, as potential biological control agents, into the Insect Quarantine Laboratory at Lincoln in 1992 and 1993.

Aphidius sonchi (Hymenoptera: Aphidiidae) is a parasitoid of the sowthistle aphid (*Hyperomyzus lactucae*) (the target species). This aphid is found on sowthistle (*Sonchus oleraceus*) in Europe and Australia. The sexual forms of *H. lactucae* infest blackcurrant, causing leaf distortion (W. Thomas pers. comm.). Migrant winged adults may transmit Lettuce Necrotic Virus to lettuce (Fry *et al.* 1973). *Hyperomyzus* spp. are the only known hosts of *A. sonchi* in the field (Mackauer and Stáry 1967). *Ephedrus cerasicola* (Hymenoptera: Aphidiidae) has been recorded as a parasitoid of the green peach aphid (*Myzus persicae*) (the target species) and nine other species of the tribe Macrosiphini in Europe (Stáry and Stechmann 1990). The green peach aphid is a vector of several virus diseases of field crops and vegetables.

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METHODS

Aphids and host plants

A total of 23 aphid species were exposed to oviposition by parasitoids in the laboratory (Table 1). Common names listed in Ferro *et al.* (1977) are used, and unlisted species are given appropriate common names based on the host plant. Aphids were chosen to represent the main groups in New Zealand: tribe Macrosiphini comprising introduced aphids and tribe Aphidini and subfamily Drepanosiphinae comprising introduced and native aphids. Test aphids were presented to parasitoids on rape (*Brassica napus*) for green peach aphid and false cabbage aphid, cleavers (*Galium aparine*) for 'black cherry aphid', yarrow (*Achillea millefolium*) for shallot aphid, Californian thistle (*Cirsium arvense*) for 'thistle aphid', sowthistle (*Sonchus oleraceus*) for sowthistle aphid and 'black sowthistle aphid', barley (*Hordeum vulgare*) for rose-grain aphid, blackberry-cereal aphid, cereal aphid and corn-leaf aphid, broad bean (*Vicia faba*) for black bean aphid, mallow (*Malva neglecta*) for potato aphid, squash (*Cucurbita maxima*) for melon aphid, ivy (*Hedera helix*) for 'ivy aphid', epilobium (*Epilobium rotundifolium*) for 'epilobium aphid', silver birch (*Betula pendula*) for 'silver birch aphid' and hazel (*Corylus* sp.) for hazel aphid. Five species of native aphids (out of a total of seven known species) were presented on the plant species from which they were collected: wineberry (*Aristotelia serrata*) for 'wineberry aphid', coll. Hokonui Hills, Southland; coprosma (*Coprosma crassifolia*) for 'coprosma aphid', coll. Aniseed Valley, Nelson; totara (*Podocarpus totarae*) for 'totara aphid', coll. Riccarton Bush, Canterbury; hard beech (*Nothofagus truncata*) for 'hard beech aphid', coll. Mount Albert, Auckland; sedge (*Carex geminata*) for 'sedge aphid', coll. Foxton swamp, Manawatu.

Aphidius sonchi

Sowthistle aphid mummies containing developing *A. sonchi* were collected from numerous sites in SE Australia and returned to the Insect Quarantine Laboratory at Lincoln. Emerging adult parasitoids were used to found a culture on sowthistle aphids. Host range tests were carried out in 350 x 240 mm plastic bins 150 mm deep, each with a gauze lid, held in the laboratory at a constant temperature of 20°C. Three treatments were employed: 100 individuals of all stages of the aphid species under test were caged on its host plant (Test); 100 sowthistle aphids were caged alone on sowthistle (Control); these two treatments, each with 50 aphids, were caged together in a choice test (Choice). Three replicates of each treatment were set up. Three mated pairs of *A. sonchi* were then added to each cage, and removed 14 days later. Honey-water was provided as food for the parasitoids. The long exposure period was used in order to ensure high parasitism rates in the Control treatment. Aphid mummies were collected, identified to aphid species and counted at 14, 21 and 28 days after the start of the test. This material was held individually until emergence of the adult parasitoid. Samples of up to 100 parasitoids from each test were examined and all were identified as *A. sonchi*.

Ephedrus cerasicola

Green peach aphid mummies containing the parasitoid were imported into the Lincoln quarantine facility from the Norwegian Plant Protection Institute, where Dr Trond Hofsvang maintained a culture founded on *E. cerasicola* collected throughout Europe. At Lincoln, the parasitoids were reared on green peach aphid on rape. No-choice tests were carried out in three 350 x 240 mm cages each containing 150-200 first and second instar aphids of the species under test on the appropriate host plant, held in the laboratory at a constant temperature of 20°C. Three mated pairs of parasitoids were added to each cage and removed 24 h later. Samples of 75-150 aphids in the fourth instar and adult stage were dissected 7 days after the end of exposure, and the presence of parasitoid larvae was recorded. The short exposure, and dissection, were used in order to speed up the testing procedure. Groups of 1-5 aphid species were tested at one time, accompanied by a green peach aphid control treatment.

Species that were parasitised in this test were then placed in a choice test. This comprised three 350 x 240 mm cages each containing 150-200 first and second instar green peach aphids on a rape plant and the same number of aphids of the species under

test on their host plant. Three mated pairs of parasitoids were added to each cage and removed 24 h later. Subsequent procedures were those used in no-choice tests. In a further no-choice test aphids were not dissected but maintained under observation at 1-3 day intervals in order to record times required for mummy formation and the emergence of adult parasitoids. All emerged parasitoids were identified as *E. cerasicola*.

TABLE 1: Rates of parasitism (P%) for *E. cerasicola*, and total mummies of *Aphidius sonchi* (No.P) in no-choice (Test) and choice (Choice) tests. Elapsed time to first adult eclosion of *E. cerasicola* is indicated by prefixes 'a' (18-20 days), 'b' (21-24 days) and 'c' (>35 days). The ratios of test aphid parasitism/control aphid parasitism (Ratio) in choice tests are given. Non-standard common names are indicated ('').

Aphid species	Common name	<i>Ephedrus cerasicola</i>			<i>Aphidius sonchi</i>		
		Test P %	Choice P %	Ratio	Test No.P	Choice No.P	Ratio
Subfamily Aphidinae							
Tribe Macrosiphinae							
<i>Myzus cerasi</i>	'black cherry'	a 61.4	-	-	0	0	<0.1
<i>Myzus persicae</i>	green peach	a 27.4*	20.0*	-	42	28	0.5
<i>Myzus ascalonicus</i>	shallot	- 0.0	-	-	-	-	-
<i>Lipaphis erysimi</i>	false cabbage	a 25.0	27.3	1.6	11	9	0.1
<i>Hyperomyzus lactucae</i>	sowthistle	a 10.0	7.2	0.6	*238	*169	-
<i>Capitophorus elaeagnoides</i>	'thistle'	a 48.9	90.0	4.1	0	0	<0.1
<i>Uroleucon sonchi</i>	'black sowthistle'	b 0.7	5.0	0.2	145	54	0.8
<i>Metopolophium dirhodum</i>	rose-grain	- 0.6	-	-	304	566	1.7
<i>Sitobion fragariae</i>	blackberry-cereal	b 4.0	23.4	0.5	-	-	-
<i>Macrosiphum euphorbiae</i>	potato	- 0.0	-	-	0	0	<0.1
Tribe Aphidini							
<i>Rhopalosiphum maidis</i>	corn-leaf	- 2.6	-	-	>900	91	0.3
<i>Rhopalosiphum padi</i>	cereal	b 1.3	0.0	<0.1	2	0	<0.1
<i>Paradoxaphis aristoteliae</i> #	'wineberry'	b 72.4	-	-	-	-	-
<i>Aphis epilobii</i>	'epilobium'	a 0.6	2.2	0.1	0	0	-
<i>Aphis coprosmae</i> #	'coprosma'	c 33.3	0.0	<0.1	-	-	-
<i>Aphis craccivora</i>	black bean	-	-	-	0	0	<0.1
<i>Aphis gossypii</i>	melon	c 16.5	14.4	1.7	2	0	<0.1
<i>Aphis hederæ</i>	ivy	-	-	-	0	0	<0.1
Subfamily Drepanosiphinae							
<i>Betulaphis quadrituberculata</i>	'silver birch'	-	-	-	0	0	<0.1
<i>Myzocallis coryli</i>	hazel	- 0.0	-	-	0	0	<0.1
<i>Neophyllaphis totarae</i> #	'totara'	c 25.0	25.9	1.6	0	0	<0.1
<i>Sensoriaphis nothofagi</i> #	'hard beech'	b 66.3	-	-	-	-	-
<i>Thripsaphis foxttonensis</i> #	'sedge'	c 2.8	1.8	0.1	-	-	-

NZ native species - no data * mean of control aphid data

RESULTS

Aphidius sonchi

In no-choice tests, the rate of parasitism by *A. sonchi* was greatest in the sowthistle aphid, 'black sowthistle aphid', rose-grain aphid and corn-leaf aphid, intermediate in the green peach aphid and false cabbage aphid, and negligible or zero in other species (Table 1). Sowthistle aphid controls in no-choice tests yielded between nine and 500 mummies, numbers varying with the extent of fungal disease infection (probably *Erynia neoaphidis*). Ratios of *n* mummies (Test)/*n* mummies (Control) in choice tests showed that parasitism was consistently greater on sowthistle aphid than on other species under test, except in the case of rose-grain aphid (Table 1). Rates of parasitism varied greatly between species of *Myzus* and *Rhopalosiphum*, and within Macrosiphini.

Rates of parasitism were zero or negligible in no-choice tests of *Aphis* spp. and Drepanosiphinae, and consistently zero in choice tests of these aphids (Table 1).

Ephedrus cerasicola

In no-choice tests, rates of parasitism among Macrosiphini were greatest in the 'black cherry aphid', 'thistle aphid' and false cabbage aphid. Parasitism varied between 10% and 45% in the green peach aphid controls. Zero or negligible parasitism occurred in the shallot aphid, potato aphid and rose-grain aphid. Among Aphidini and Drepanosiphinae, parasitism by *E. cerasicola* was greatest in native aphids - wineberry aphid, coprosma aphid, totara aphid and hard beech aphid (Table 1). Parasitoid larvae dissected from these natives (and from the sedge aphid) were predominantly in the first and second instars, in contrast to the second and third instar larvae found in Macrosiphini. Larvae of *E. cerasicola* pass through four larval instars (Hofsvang and Hagvar 1978). Table 1 shows that first eclosion of adult parasitoids occurred after 18-24 days in Macrosiphini and in three species of Aphidini, and in one species of Drepanosiphinae. Between 17 and 200 adult parasitoids emerged from each of these aphid species. Parasitoids emerging from wineberry aphids ($n=47$) successfully parasitised green peach aphids, from which a second generation of adult parasitoids emerged. Parasitoid larval development was prolonged beyond 35 days in the native coprosma aphid and sedge aphid, and 1-3 adult parasitoids emerged from these species. No adult parasitoids emerged from totara aphids. In choice tests (Table 1), ratios of test/control parasitism rates suggested that *E. cerasicola* preferred, as hosts, the false cabbage aphid, 'thistle aphid', melon aphid and 'totara aphid' over the green peach aphid controls, in which parasitism rates varied between 9% and 46%.

DISCUSSION

Test results for *A. sonchi* were presented in an Importation Impact Assessment (IIA) statement submitted through MAF Regulatory Authority to a panel of consultants. Several respondents considered that the wide host range, including parasitism of the corn-leaf aphid, did not indicate a zero or negligible threat to the native fauna and were critical of the limited testing of native aphids. We argued that the results were the effect of caging (Sands 1993). For example, Aeschliman and Vitou (1985) showed, in a survey of sowthistle insects in the Mediterranean region, that 'black sowthistle' aphids sharing the plants with sowthistle aphids were never parasitised by *A. sonchi*, contrary to our laboratory results (Table 1). We requested permission to release the parasitoid on the grounds that field records showed *A. sonchi* to be restricted to *Hyperomyzus* spp. (Mackauer and Stáry 1967) and that parasitism was zero or negligible in seven species of *Aphis* and Drepanosiphinae closely related to natives (Table 1). Permission to release *A. sonchi* was given in early 1994. The parasitoid was released at several sites in both Islands, and is now established.

E. cerasicola was selected as a candidate control agent because field work in Europe indicated that it was restricted to ten species of Macrosiphini in the genera *Myzus*, *Hyperomyzus*, *Cryptomyzus*, *Ovatus*, *Nasonovia*, *Capitophorus* and *Dysaphis* (Stáry and Stechmann 1990). In laboratory cage trials, these authors showed that a wide range of Macrosiphini were attacked, but not *Aphis* spp, including the melon aphid. Our trials showed that, under the test conditions, *E. cerasicola* parasitised the melon aphid and all five native aphid species (Aphidini and Drepanosiphinae) that were tested. The 'wineberry aphid' was severely parasitised and although parasitoid larval development was initially retarded, the speed of development to the adult stage and the number of adults produced was similar to that found in macrosiphine hosts. The wineberry aphid shares several taxonomic features with the Macrosiphini (Sunde 1988) and its status as a host to *E. cerasicola* may be linked with a close relationship to the Macrosiphini. We have no way of knowing whether *E. cerasicola* would seriously parasitise native aphids in the field, or even drive them to extinction. However, responses to the IIA report on *A. sonchi* indicated that the climate of opinion among ecologists and other consultants accepts these possibilities. The application for release of *A. sonchi* was successful because the IIA report showed that close relatives

of native aphids were not parasitised. We think that *E. cerasicola* would not be approved for release, as this species parasitised all five native aphids tested, with particular efficiency in the case of the wineberry aphid. We have therefore destroyed the parasitoid culture and no IIA is to be submitted to MAF Regulatory Authority. The field host range of *A. sonchi* is to be monitored to allow comparison with laboratory results.

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