NATURAL ENEMIES OF BRIDAL CREEPER, *ASPARAGUS ASPARAGOIDES*, IN NEW ZEALAND

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ABSTRACT

Bridal creeper is a weed of natural and productive areas in the northern North Island of New Zealand. A classical biocontrol programme was initiated in 2005–2007 with a survey of invertebrate fauna and pathogens associated with the weed in New Zealand. Although bridal creeper was attacked by a wide range of generalist invertebrates, their overall damage affected <1% of total plant biomass. However, a specialist rust fungus, *Puccinia myrsiphylli,* which was deliberately introduced into Australia to control bridal creeper in 2000, was detected in New Zealand for the first time. Our surveys indicate that it has spread autonomously over most of the weed's range in northern New Zealand. Damage was often severe, causing up to 100% premature defoliation. It may also form a synergistic disease complex with another widespread primary fungal pathogen of bridal creeper, *Colletotrichum gloeosporioides*. The rust appears to be an effective biocontrol agent for bridal creeper in New Zealand.
Keywords: environmental weed, classical biological control, plant pathogens, invertebrates, parasitoid, predators.

INTRODUCTION

The scrambling perennial vine bridal creeper, *Asparagus asparagoides* (L.) W. Wight Asparagaceae, also known as smilax in New Zealand, is native to southern Africa. It naturalised in New Zealand by the early 1900s (Esler 2004), having been introduced earlier as an ornamental garden plant. It is now common in the northern half of New Zealand particularly Northland, Auckland, Waikato, Bay of Plenty and Gisborne. Although less common further south, it can be found in Wairarapa, Wellington, Nelson, Blenheim, Christchurch and Banks Peninsula. Similarly introduced to Australia in the 1870s, it has now naturalised in all southern states of Australia in a wide range of habitats. In both countries bridal creeper is a serious invasive environmental weed (Roy et al. 2004; Morin & Edwards 2006).

In New Zealand, bridal creeper is a weed of forest margins, open woodlands, hedges and coastal slopes (Roy et al. 2004; Waipara et al. 2006), and is particularly invasive in natural and productive areas of the northern regions of the North Island. It competes aggressively with other plants by forming dense canopies that block sunlight, and producing thick mats of tubers and rhizomes that prevent seedling establishment of other plants (Esler 2004). Wiry stems with light green leaf-like cladodes arise from tubers and can reach as high as 3 m on supporting vegetation. Small greenish-white flowers appear from winter (July-August), followed by sticky red berries containing black seeds in summer. The leaves and stems tend to die back in summer and re-sprout from tubers and rhizomes in autumn. The plant is spread readily by birds, which eat the berries and distribute seed in their droppings, and by movement of root material through activities such as dumping garden waste. Bridal creeper is tolerant of a wide variety of conditions including shade, making it a highly successful invader of both disturbed and undisturbed habitats including areas that are inaccessible for both detection and control. Bridal creeper infestations can have deleterious environmental impacts by changing the structure, floristic composition and ecology of ecosystems (Morin & Edwards 2006).

Current control methods for bridal creeper can be both uneconomic and in some situations inappropriate (Morin et al. 2002). Biological control was proposed as a management tool for bridal creeper in New Zealand (Syrett 1999) as it offers some advantages over current control methods, particularly in areas of high conservation value (by reducing chemical herbicide impacts on desirable flora) and in inaccessible areas that are difficult to treat conventionally. Unlike current control methods, biocontrol also offers continuous action and self-dispersal and it can complement other management strategies. A classical biocontrol programme was initiated in Australia in the 1990s, where a leaf rust, *Puccinia myrsiphylli*, a leaf hopper, *Zygina* sp. (Cicadellidae), and a leaf beetle, *Crioceris* sp. (Chrysomelidae), have been released (Morin & Edwards 2006). The rust and the leaf hopper have established widely and demonstrated capacity to significantly reduce the density of bridal creeper populations (Morin & Edwards 2006) indicating their potential for successful biocontrol of bridal creeper in New Zealand.

As part of the proposed classical biological control programme, a survey of the invertebrate fauna and plant pathogens associated with bridal creeper in New Zealand was undertaken. The main aims of the survey were to determine whether any specialist bridal creeper invertebrates or fungi are already present in New Zealand, whether any generalist invertebrate herbivores or fungal pathogens are exerting a significant adverse impact on bridal creeper in New Zealand, and to record the invertebrate parasitoids and predators associated with the herbivorous invertebrates on bridal creeper.

MATERIALS AND METHODS

Survey of invertebrates on bridal creeper

The herbivorous invertebrate fauna of bridal creeper was surveyed at 32 sites throughout its range in New Zealand between November 2005 and January 2007. At each site, 10 collection locations were selected haphazardly. A collecting tray (80 cm x 80 cm) was placed under suitable parts of selected plants, and the foliage above the tray was hit five times with a solid stick. Invertebrates that fell onto the tray were collected with an aspirator for identification. Immature life stages were collected for rearing to adults. Foliage growing points and stems were also inspected, along with the tuberous root systems of five plants, for signs of invertebrates, which were then collected for identification. If fruit was present, approximately 100 berries were collected and stored in ventilated containers to collect fruit- and seed-feeders. A visual estimate was made of the amount of herbivore-related damage at each site, and likely cause noted. The invertebrates collected were identified to species or genus level. They were then ranked on a scale of abundance according to the total number of individuals collected, and the number of sites at which they were present. They were classed as rare, occasional, common or abundant according to the definitions below:

rare: fewer than 5 individuals collected across all 32 sites
occasional: 5–24 individuals present **or** present at fewer than five sites
common: 25+ individuals collected **and** present at five or more sites
abundant: 200+ individuals collected **and** present at 10 or more sites.

Predatory and parasitoid species that may also inhibit biological control agents introduced in the future were also recorded.

Survey of plant pathogens on bridal creeper

Plants were also inspected for signs of pathogen damage at the same 32 sites from which invertebrates were collected plus five additional sites. At each site, plants at 10 collection points were examined closely for signs of pathogen damage and other bridal creeper plants in the area were inspected more superficially for obvious disease symptoms. The five tuberous root systems inspected for invertebrate damage were also inspected for fungal damage. Any diseased leaves, leaf petioles, stems, flowers, flower petioles, berries or roots found were collected for processing. Disease symptoms were recorded and photographed. A dissecting microscope was used to search necrotic areas for diagnostic fungal reproductive structures as well as pustules of the bridal creeper rust (*P. myrsiphylli*). Small pieces of tissue, ca 3 x 3 mm (251 in total), were cut from the edge of diseased areas and surface-sterilised by immersion in 2% hypochlorite for 1 min, followed by two rinses in sterile water. These were placed on potato dextrose agar (Difco Labs, Detroit, MI, USA) with 0.02% streptomycin (Sigma, St Louis, MI, USA), contained in 9 cm Petri dishes. Plates were incubated under near-ultraviolet and white light (12 h photoperiod) at temperatures of 22 ± 2°C (day) and 18 ± 2°C (night). Microcolonies that were initiated from tissue fragments were sub-cultured for further identification.

RESULTS

Survey of invertebrates on bridal creeper

Seventy-six herbivorous invertebrate species were identified, none of which were specialist herbivores of bridal creeper, although the portulaca leaf-mining weevil *Hypurus bertrandi* (recorded in New Zealand for the first time, at Mangere, in August 2006) was a noteworthy discovery. In addition, 10 groups of taxonomically related herbivores could not be identified to species level. Two species, *Siphanta acuta* and *Scolypopa australis* (the passionvine hopper), were classed as 'abundant' (Table 1), nine species or taxonomic groupings were classed as 'common', 24 were classed as 'occasional' and 51 were classed as 'rare'. The overall damage attributed to invertebrate herbivory was minimal. It was rare to find a leaf >20% consumed, and the overall amount of foliage that appeared to be consumed or damaged by herbivores was estimated to be <1%. The most obvious foliage damage was attributed to moth larvae, especially tortricids (leafrollers) and, to a lesser extent, noctuids. The banana silvering thrips, *Hercinothrips bicinctus* (Bagnall) (Thripidae), were numerous at some sites and caused silvery-coloured patches on the foliage. Little or no damage was observed on flowers, fruit or roots.

Over 45 predator and four parasitoid species were identified. Most common were spiders and a native braconid (*Glyptapanteles demeter*) respectively.

Survey of plant pathogens on bridal creeper

A range of disease levels, from mild to severe necroses, was observed on plants sampled across all sites. High levels of damage at some sites (up to 100% premature defoliation of the plant prior to fruit ripening and natural summer senescence) were caused by the bridal creeper rust, *Puccinia myrsiphylli*, found in New Zealand for the first time during these surveys (Waipara et al. 2006). The rust was recorded on samples from 15 sites across most of the weed's North Island distribution (Northland to Wairarapa), but was absent from samples collected from the East Coast (North Island) or the South Island.

At least 25 fungal species were identified, based on cultural morphology and reproductive (sporulation) characteristics, after being isolated into pure culture. A second primary pathogen, *Colletotrichum gloeosporioides*, was the most frequently isolated fungal pathogen in the survey. It was primarily associated with a range of stem and leaf necroses, and was twice isolated from the tuber tissues suggesting that infection could have been systemic on some plants. Despite the range of shoot necroses caused by *C. gloeosporioides*, overall damage to the plant was minimal from this pathogen alone. However, levels of damage by this fungus were higher when associated with rust outbreaks on the plant (Table 3). Of the plant samples that showed damage from the fungus, the proportion that had medium to high damage was significantly higher in the presence than in the absence of the rust (Fisher exact test $P<0.001$). The remainder of isolates from symptomatic root and tuber tissues were considered to be secondary, weakly pathogenic or saprophytic with little to no impact on the overall health of bridal creeper. Some weak and secondary opportunistic leaf pathogens were associated with minor superficial leaf, stem and tuber necroses on bridal creeper. No significant primary flower pathogens were isolated.

TABLE 1: Herbivorous invertebrates collected from bridal creeper in New Zealand during 2005–2007[1].

Taxon/Species	Common name	Feeding niche	Frequency (no. sites out of 32)	Origin
Curculionidae	**weevils**			
Asynonychus cervinus	Fuller's rose weevil	foliage	common (7)	exotic
Delphacidae				
Ugyops pelorus		sap feeder	common (6)	native
Flatidae	**planthoppers**			
Siphanta acuta	green planthopper	sap feeder	abundant (25)	exotic
Pentatomidae	**shield bugs**			
Cuspicona simplex	green potato bug	sap feeder	common (9)	exotic
Nezara viridula	green vegetable bug	sap feeder	common (15)	exotic
Ricaniidae	**planthoppers**			
Scolypopa australis	passionvine hopper	sap feeder	abundant (11)	exotic
Tortricidae	**leaf rollers**			
Ctenopseustis obliquana or *C. herana*		foliage	occasional (6)	native
unidentified Tortricidae		foliage	common (13)	
Gastropoda	**slugs/snails**			
Cantareus aspersa	brown garden snail	foliage	common (9)	exotic
Thysanoptera	**thrips**			
Hercinothrips bicinctus	banana silvering thrips	foliage	common (6)	exotic

[1]A complete appendix of all invertebrates identified from this survey of bridal creeper is found in Harman et al. (2008).

TABLE 2: Primary and secondary pathogens observed damaging bridal creeper in New Zealand during 2005-2007.

Fungi	No. sites	No. isolates	Leaf/stem tissue	Tuber/ root tissue	Flower/ fruit tissue
Primary pathogens					
Puccinia myrsiphylli	15+	25	+		+
Colletotrichum gloeosporioides	16	58	+	+	
Secondary pathogens					
Alternaria alternata	10	21	+		+
Botrytis cinerea	8	23	+	+	+
Fusarium spp. (3 species)	10	24	+		
Pestalotiopsis sp.	2	4	+	+	
Phoma spp. (3 species)	3	6	+		
Phomopsis sp.	10	17	+	+	
unidentified coelomycete spp.	6	11	+	+	
Ulocladium sp.	1	1	+		

TABLE 3: Symptoms and severity of *Colletotrichum gloeosporioides* disease on bridal creeper with (+) and without (-) rust infection.

		Colletotrichum (+) rust		*Colletotrichum* (-) rust	
Damage	Symptoms	No. isolates	No. samples	No. isolates	No. samples
minor	tuber discolouration			2	1
minor	leaf chlorosis			4	3
minor	leaf spots (1-3 spots/leaf)	4	2	4	3
medium	leaf spots (4-8 spots/leaf)	12	3		
high	leaf spots (>9 spots/leaf)	23	10		
high	leaf dieback	2	2		
high	leaf death	0	2		
high	stem necroses	7	3		
	Total	48	22	10	7

DISCUSSION

The bridal creeper rust fungus, *Puccinia myrsiphylli*, which was released in Australia in 2000 as part of the Australian classical biological control programme, is now present in New Zealand. Since its arrival, the rust has autonomously spread over most of the weed's exotic range in northern New Zealand. Bridal creeper was attacked and damaged by the rust over its two active growing seasons (winter-spring, autumn). Damage was often severe, causing up to 100% premature defoliation of the plant prior to both fruit ripening and natural senescence. Observations and studies in Australia indicate that the rust is very damaging to bridal creeper with the cumulative effect over several seasons on above- and below-ground biomass and fruit set likely to reduce plant vigour and density (Morin et al. 2002; Morin & Edwards 2006). The rust alone is, therefore, likely to be an effective biocontrol agent for bridal creeper in New Zealand. Furthermore, although the other primary fungal pathogen of bridal creeper detected in this survey, *C. gloeosporioides*, caused only mild damage to the plant on its own, increased levels of infection and damage by *C. gloeosporioides* were observed whenever it was found associated with *P. myrsiphylli*.

Given the widespread and often severe damage to bridal creeper in New Zealand caused by the rust, sourcing additional agents for the classical biological control programme is unwarranted until the impact of the rust on bridal creeper populations has been assessed. Such assessment would require monitoring of the rust's effectiveness in reducing the spread and the biomass of the weed. An application by ERMA NZ to 'de-new' the rust under the HSNO Act is being pursued, so that it is no longer regarded legally as a new organism. This would allow land managers to actively manipulate the rust to increase biocontrol efficacy, using methods such as early season augmentation, and introduction to areas where it has not autonomously spread (e.g. South Island). The legislative change would also allow laboratory studies to assess the impact of the disease.

The total amount of damage to bridal creeper foliage at the survey sites that was attributed to herbivorous insects was estimated to be less than 1%, and none of the invertebrate 'herbivore' niches on bridal creeper are well-utilised in New Zealand. Indeed, some niches, such as leaf-mining, are not occupied. Specialised bridal creeper biocontrol agents are, therefore, unlikely to encounter significant competition from resident herbivores. There is, therefore, scope for the introduction of host-specific invertebrate biocontrol agents such as the leaf hopper, *Zygina* sp., and the leaf beetle, *Crioceris* sp., (Morin & Edwards 2006) if it is demonstrated that additional agents are likely to enhance the impact of *P. myrsiphylli*.

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REFERENCES

Esler AE 2004. Wild plants in Auckland. Auckland University Press, Auckland. 218 pp.

Harman HM, Waipara NW, Winks CJ, Smith LA, Peterson PG, Wilkie JP 2008. Invertebrates and fungi associated with bridal creeper, *Asparagus asparagoides* (Asparagaceae), in New Zealand. Landcare Research Contract Report No. LC0708/124, Landcare Research, Auckland, New Zealand. 32 pp.

Morin L, Edwards PB 2006. Selection of biological control agents for bridal creeper: a retrospective review. Australian Journal of Entomology 45: 287–291.

Morin L, Willis AJ, Armstrong J, Kriticos D 2002. Spread, epidemic development and impact of the bridal creeper rust in Australia: summary of results. In: Spafford Jacob H, Dodd J, Moore JH ed. Proceedings of the 13th Australian Weeds Conference. Plant Protection Society of WA Inc., Perth, Australia. Pp 385–388

Roy B, Popay I, Champion P, James T, Rahman A 2004. An illustrated guide to common weeds in New Zealand. 2nd edition. New Zealand Plant Protection Society, Lincoln, New Zealand.

Syrett P 1999. Prospects for biological control of climbing asparagus, *Asparagus scandens* Thunberg (Asparagaceae). Landcare Research Contract Report No. LC9899/104, Landcare Research, Lincoln, New Zealand. 15 pp.

Waipara NW, McKenzie EHC, Harman HM, Winks CJ, Park D 2006. First record of bridal creeper rust, *Puccinia myrsiphylli*, a classical biocontrol agent of the environmental weed bridal creeper, *Asparagus asparagoides*, in New Zealand. Australasian Plant Disease Notes 1: 23–24.