Environmental Protection Authority
Te Mana Rauhī Taiao

APPLICATION FORM
RELEASE

Application to import for release or to release from containment new organisms

under the Hazardous Substances and New Organisms Act 1996

Send by post to: Environmental Protection Authority, Private Bag 63002, Wellington 6140 OR email to: noinfo@epa.govt.nz

Application number

APP201363

Applicant

Environment Southland
Private Bag 90116
Invercargill 9840
(03) 211 5115

Key contact

Randall Milne, Senior Biosecurity Officer (Pest Plants)

Important

This application form is to seek approval to import for release or release from containment new organisms (including genetically modified organisms).

The application form is also to be used when applying to import for release or release from containment new organisms that are or are contained within a human or veterinary medicine.

Applications may undergo rapid assessment at the Authority's discretion if they fulfil specific criteria.

This application will be publicly notified unless the Authority undertakes a rapid assessment of the application.

This application form will be made publicly available so any confidential information must be collated in a separate labelled appendix.

The fee for this application can be found on our website at www.epa.govt.nz.

If you need help to complete this form, please look at our website (www.epa.govt.nz) or email us at noinfo@epa.govt.nz.

This form was approved on 1 May 2012.

1. Brief application description

Provide a short description (approximately 30 words) of what you are applying to do.

To import and release two weevils, *Anthonomus kuscheli* and *Berberidicola exaratus*, as biological control agents for the weed Darwin's barberry (*Berberis darwinii*).

2. Summary of application

Provide a plain English, non-technical description of what you are applying to do and why you want to do it.

The National Biocontrol Collective comprises 13 regional councils and the Department of Conservation (DOC). It has determined that biological control is the most likely means of achieving environmentally acceptable and cost-effective management for the weed Darwin's barberry (*Berberis darwinii*) in New Zealand. Environment Southland (ES) makes this application on their behalf. Landcare Research and Dr Hernán Norambuena have provided the research described in the application. Richard Hill & Associates prepared the application and managed the application process.

Darwin's barberry (*Berberis darwinii*) is a threat throughout New Zealand and features in the Regional Pest Management Strategy (RPMS) of 9 regions: Auckland, Waikato, Bay of Plenty, Taranaki, Horizons, Gisborne, Greater Wellington, West Coast, Canterbury and Southland. It invades pasture, disturbed forest, shrub-land, tussock-land, along roadsides and other scarcely vegetated sites. The seeds are spread long distances by birds that eat the berries. Darwin's barberry can grow more rapidly than native species when suitable conditions arise, dominating sites where it establishes. It can suppress existing vegetation and prevent the establishment of desirable plants. Darwin's barberry can persist under canopy in forest and shrub-land.

Environment Southland has prepared a Regional Pest Management Strategy (RPMS) designed to minimise the actual and potential effects of plant pests in the environment and the community. Under this strategy the land occupier is largely responsible for managing pests on that land. However, ES acts to maximise the effectiveness of individual actions through a regionally co-ordinated approach. We have declared Darwin's barberry to be a 'containment pest' and defined a Containment Area in the eastern half of the region (Landcare Research, 2012). We aim to:

1. Destroy Darwin's barberry wherever it is found outside the Containment Area, and
2. Implement policies that reduce its distribution and abundance within the area, particularly where it damages native habitats of high ecological value. This includes support of the Department of Conservation (DOC) programme to eradicate Darwin's barberry on Rakiura (Stewart Island) and community initiatives to destroy the weed in High Value Areas within the Containment Area.

The key to success of Darwin's barberry management is to reduce the risk that Darwin's barberry will reinvade cleared sites or expand its distribution. To this end, we wish to limit the ability of the weed to disperse by introducing biological control agents that reduce seed production and dispersal. Its distribution in all regions is still limited, and it is important to reduce the ability of this weed to extend its range within those regions.

This application proposes the introduction of two weevils: *Anthonomus kuscheli* which destroys flower buds, reducing flowering and fruiting, and *Berberidicola exaratus* which feeds on seeds within the remaining fruits. Biological control introduces and establishes safe natural enemies that prey on and harm pest populations. Because these natural enemies are established in the environment, their effects are widespread and persist from year to year. Agents are self-dispersing and can locate host plants that are unknown to weed managers. This is the first biological control programme ever mounted against this weed.

The expected positive effects of biological control of Darwin's barberry using these two weevils include:

- Reduced invasion of un-infested land
- Reduced damage to native ecosystems in the long-term
- Reduced control costs to farms, businesses and communities in the long-term
- Improved allocation of resources to maintain biodiversity values in the long-term.

Introduced natural enemies must be safe if this weed management tactic is to be environmentally acceptable. Significant adverse effects on the environment or on productive values would occur if either insect attacked valued non-target plants, but this application presents evidence that neither will cause significant damage to desirable plants in New Zealand. Dr Hernán Norambuena (initially of the Instituto de Investigaciones Agropecuarias, Chile) conducted field experiments in Chile to assess the risk that these two insects might pose. Adult weevils were confined in cloth bags on a range of flowering plants related to Darwin's barberry. After a time, flower buds were examined for attack by *Anthonomus kuscheli* larvae, and fruits were examined for the presence of *Berberidicola exaratus* larvae. *Anthonomus kuscheli* was able to develop in only one other barberry species (*B. thunbergii*) and is clearly highly specific to Darwin's barberry. *Berberidicola exaratus* larvae were found in several barberry species within one subfamily, but did not develop successfully on any plant outside the family Berberidaceae.

History shows that plants closely related to the target plant are the species most likely to be damaged by control agents. There are no native species in this family in New Zealand, and so none will be at risk from these weevils. Selected tests on native plants conducted in containment in New Zealand supported this conclusion. The results of all tests are summarised in Section 6.2, and the detail can be found on the Landcare Research website (Landcare Research, 2012). No significant harm to the aesthetic value of ornamental barberries is expected because adult weevils only nibbled foliage. However, the seed production of some species could be reduced. No other significant adverse environmental or economic effects are considered likely. *Berberidicola exaratus* attacked the fruits of common barberry (*Berberis glaucocarpa*) in tests, and could be a biological control agent for this emerging weed as well.

Darwin's barberry is still of limited distribution in New Zealand, and this proposal is targeting the weed before it generates large costs here. Estimates of the potential environmental and economic benefits of biological control based on existing effects are modest or long-term (Section 6.6).

Darwin’s barberry invading pastoral land in Otago (photographs courtesy of DOC).

Darwin’s barberry persisting in light gaps and under regenerating native vegetation in Otago.

3. Describe the background and aims of the application

This section is intended to put the new organism(s) in perspective of how they will be used. You may use more technical language but please make sure that any technical words used are included in a glossary.

The aim of this proposal is to reduce the rate at which satellite populations of Darwin's barberry establish across the landscape by reducing the number of seeds available for dispersal by birds.

Darwin's barberry is native to South America, and occurs from approximately 33° to 46° S in Chile (Norambuena, 2011). It is considered to be invasive in New Zealand, Australia, Ireland and the Falkland Islands. It has naturalised in the Pacific states of USA (ISSG, 2010) but is not yet considered a significant weed there. It was recorded as naturalised in New Zealand in 1946, and can be found from central North Island to Stewart Island (Webb et al., 1988). Darwin's barberry occurs from Waikato south, but it is not yet abundant throughout that distribution. It can tolerate frost and drought (in McAlpine & Jesson, 2007). There are not many major infestations within its current range but there seems no climatic reason why it cannot spread throughout lowland New Zealand.

Darwin's barberry is an evergreen, spiny shrub that grows up to 5 m tall in the open and at forest edges. In South America it forms a permanent understory in some *Nothofagus* forests (in McQueen, 1993). The light levels in intact New Zealand podocarp and beech forest appear to be too low for barberry seedlings to survive, and invasion success is low (McAlpine & Wotton, 2012). However, it can aggressively invade forest margins and light gaps in disturbed or remnant forest. Seedlings survive better in high light conditions, but those that establish in shade are then able to persist and establish dense biomass there (Allen & Wilson, 1992; McAlpine, 2005; McAlpine & Jesson, 2008). Darwin's barberry overtops and destroys low-growing native plants that should grow in such areas, including seedling forest trees (McAlpine & Jesson, 2008). As a regenerating forest canopy closes, Darwin's barberry can persist for many years in the understory (Allen & Wilson, 1992), Few other exotic species compete with natives in deep shade in this way (McQueen, 1993) and the long-term consequences of a persistent Darwin's barberry understory on forest ecosystems in New Zealand is not yet certain (Allen, 1991; Williams, 2011; D. Bejakovich, GWRC, pers. comm). L. Huggins (DOC, pers. comm.) has identified Darwin's barberry as a direct threat to six naturally uncommon and endangered plants growing in three areas of Southland.

Darwin's barberry is an unwanted organism and is listed in the National Pest Plant Accord (Biosecurity New Zealand, accessed 2012). It is considered a threat to the ecological and biodiversity values of reserved land managed by DOC, regional councils and other organisations. DOC and regional councils have responded to this threat by instituting resource-hungry management strategies to limit its growing impact in threatened areas throughout New Zealand (see Section 6.6). It is seen as a major threat in Rakiura National Park where an eradication campaign is in progress, and heavy infestations are controlled in other sensitive habitats. The adverse effects of Darwin's barberry on ecosystem values are currently limited because the distribution of Darwin's barberry in New Zealand is patchy, but the weed is spreading, and its impacts will increase accordingly. This annual investment simply maintains damage at current levels (see Section 6.6).

Dense stands reduce the amount of feed available to grazing stock in invaded pastures in Southland, although the significance of production losses is uncertain (see Section 6.6). Personal communications from regional councils, Federated Farmers, QEII National Trust and others regarding the pest status of Darwin's barberry were obtained from a range of sources during pre-application consultation. All personal communications can be found on the Landcare Research website (Landcare Research, 2012).

Darwin's barberry produces deep orange-yellow flowers from January to December, followed by abundant purplish-black berries (Roy et al., 2004). The berries contain up to eight seeds (Webb et al., 1988) and are highly attractive to fruit-eating birds such as blackbirds, which fly and then deposit seeds far from the parent bush. When fruits are consumed by birds, viable seeds are deposited after approximately 30 minutes (in Williams, 2006). Seeds are normally deposited when the birds perch (Allen & Lee, 1992), so become concentrated under forest margins, trees, and fence-lines. MacAlpine & Jesson (2008) found great numbers of seeds at least 150 m away from where the bird fed, and some were detected up to 450 m away. Seeds last only a short time in the litter, so there is no significant persistent seed bank. There are two major determinants of invasion success: availability of suitable microsites for seedling establishment, and how much seed birds deposit there. McAlpine and Jesson (2008) recommended that removal of seed sources should be a priority for Darwin's barberry management. The introduction of *B. exaratus* and *A. kuscheli* addresses this priority.

The rate at which new sites are colonised is related to the pattern of seed deposition by birds and the number of fruits consumed. If *Anthonomus kuscheli* and *Berberidicola exaratus* reduce the number of viable seeds available for consumption below the number currently consumed and dispersed by birds, then the rate of spread of Darwin's barberry will be reduced from current levels. Any reduction in seed consumption will lower the probability that a viable seed will be deposited in a microsite favourable to seedlings, reducing the rate at which satellite populations succeed. A high level of seed destruction will have a dramatic effect on the invasive ability of Darwin's barberry.

Both weevils are expected to eventually establish wherever Darwin's barberry occurs in New Zealand. Adult weevils will feed on the leaves, flower buds and/or flowers of barberry, but damage to foliage is expected to be trivial. *Anthonomus kuscheli* will lay eggs into flower buds. Feeding by larvae will kill a high proportion of the flower buds. This is expected to reduce the number of flowers produced by Darwin's barberry throughout New Zealand, and fewer fruits will form to be consumed by birds. *Berberidicola exaratus* will destroy seeds within the developing fruits, and a proportion of the seeds deposited by birds will be sterile. The effects of the agents will be additive because reduction in fruit production by *A. kuscheli* is likely to reduce the resource available to *B. exaratus*, increasing the proportion of seeds attacked within each fruit.

Neither weevil is expected to have any impact on the growth rate or survival of *Berberis* plants already growing in New Zealand because larvae only feed on reproductive parts of the plant, and adults feed little (see Section 6.5).

4. Information about the new organism(s)

- Provide a taxonomic description of the new organism(s) (if the organism is a genetically modified organism, provide a taxonomic description of the host organism(s) and details of the genetic modification).
- Describe the biology and main features of the organism including if it has inseparable organisms.
- Describe if the organism has affinities (e.g. close taxonomic relationships) with other organisms in New Zealand.
- Could the organism form an undesirable self-sustaining population? If not, why not?
- What is the ease with which the organism could be eradicated if it established an undesirable self-sustaining population?

4.1. Provide a taxonomic description of the new organisms

Class:	Insecta	Class:	Insecta
Order:	Coleoptera	Order:	Coleoptera
Family:	Curculionidae	Family:	Curculionidae
Sub-family:	Curculioninae	Sub-family:	Molytinae
Genus:	***Anthonomus***	Genus:	***Berberidicola***
Species:	***kuscheli*** Clark 1989	Species:	***exaratus*** (Blanchard) 1851
	(Clark & Burke, 1989)	(Kuschel, 1950)	

4.2. Describe the biology and main features of the organism including whether it has inseparable organisms

Anthonomus kuscheli

The adult is 3 mm long, and brown, with a striking pale stripe along the top and sides of the abdomen. Adults feed sparingly on flower buds and on barberry leaves. Weevils lay eggs into the flower buds of Darwin’s barberry from early spring. Hatching larvae complete development inside the flower buds, emerging as adults after about 6 weeks. This weevil has several generations each year so buds are attacked throughout the flowering period of the host plant. When only 4 weevils were bagged onto branches for one generation, 3% of flower buds developed to produce fruit compared with 21% of buds when weevils were excluded (from data in Norambuena, 2011). Adult weevils emerge when buds begin to form in spring.

Anthonomus kuscheli Clark is one of only four anthonomine weevils (family Curculionidae, subfamily Curculioninae) recorded in Chile by Clark & Burke (1989). Three of these were collected from *Berberis* species. It was recorded from approximately 35° to 45° S in Chile and western Argentina (Clarke & Burke, 1989) which coincides with the distribution of Darwin’s barberry (see Section 3). *Anthonomus kuscheli* has not been found in northern Chile or in neighbouring countries (Clarke & Burke, 1989) even though other *Berberis* species grow there. These observations suggest that *A. kuscheli* is specific to Darwin's barberry.

Adult Anthonomus kuscheli *and adult feeding punctures.*

Buds consumed by A. kuscheli *larvae, with exit holes made by emerging adults.*

Berberidicola exaratus

Adults are less than 3 mm long and uniformly dark brown. This species completes its larval stages within barberry fruits. Adults emerge from the ground in late spring. Weevils feed on flowers and foliage and create feeding punctures in developing fruits. Eggs are laid just beneath the epidermis in some of the feeding punctures in susceptible fruits. Hatching larvae migrate through the fruit to the developing seeds and consume these one at a time. Once fully grown the larvae chew their way out of the fruit and drop to the ground to pupate. This species has one generation per year.

Both species have been collected from 36° 47' S to 42° 52' S in Chile (Norambuena & Escobar 2010), and day-length effects are unlikely to limit establishment in New Zealand, even in Southland (46-47° S). The climates in the region of origin broadly match those in New Zealand, and both weevils should be able to colonise Darwin's barberry populations wherever these occur here.

No inseparable organisms have been recorded for these species. Populations will be examined for associated organisms before clearance for release is sought from the Ministry for Primary Industries (MPI).

Berberidicola exaratus *adult*

Feeding scars/oviposition sites on green Darwin's barberry fruits

Adults and larvae emerged from fruits into cloth bags

4.3. Describe if the organism has affinities (e.g. close taxonomic relationships) with other organisms in New Zealand

Anthonomus kuscheli

Anthonomus kuscheli Clark is a weevil (family Curculionidae, subfamily Curculioninae) (Clark & Burke 1989) belonging to the tribe Anthonomini. There are no known native species of this tribe in New Zealand (B. Barratt, AgResearch pers. comm.) but the sub-family (Curculionidae) is well-represented in the native fauna. These have a wide range of life histories and some attack fruit and flowers (N. Martin, pers. comm.). The natural enemies of these weevils are virtually unknown. *Anthonomus kuscheli* is likely to share habitats with these native species, but only where Darwin's barberry is present.

Berberidicola exaratus

Berberidicola exaratus (Blanchard) is a weevil (family Curculionidae, subfamily Molytinae). It was originally described by Blanchard in 1851 as *Rhyssomatus exaratus*, but was transferred to the new genus *Berberidicola* by G. Kuschel in 1950. The sub-family Molytinae is well-represented in the New Zealand fauna and includes the large, flightless *Lyperobius huttoni* and *Hadramphus* species (speargrass weevil and knobbled weevils; Craw, 1999). *Berberidicola exaratus* belongs to a different tribe in this sub-family (B. Barratt, AgResearch, pers comm.). Unlike *B. exaratus*, the native weevils do not feed as larvae in fruits or seeds, but rather in roots or stems of Apiaceae *(Aciphylla* and *Anisotome* spp.), Araliaceae *(Stilbocarpa),* and Pittosporaceae (Craw, 1999). Use of such different plant parts and habitats will isolate *B. exaratus* from these species or their natural enemies, and limit interactions.

4.4. Could the organism form an undesirable self-sustaining population? If not, why not?

The object of introducing these insects is to establish self-sustaining populations contributing to the suppression of future barberry populations. No populations of *Anthonomus kuscheli* and *Berberidicola exaratus* established in New Zealand are expected to be undesirable because neither is expected to adversely affect native plants (see Section 6.2), or to significantly reduce the utility of barberry species as hedging or garden plants (see Section 6.5). Neither agent will significantly affect extant barberry plants.

4.5. What is the ease with which the organism could be eradicated if it established an undesirable self-sustaining population?

Not Applicable

The organism that is the subject of this application is also the subject of:

a. an innovative medicine application as defined in section 23A of the Medicines Act 1981. ☐ No

b. an innovative agricultural compound application as defined in Part 6 of the Agricultural Compounds and Veterinary Medicines Act 1997. ☐ No

5. Detail of Māori engagement (if any)

Discuss any engagement or consultation with Māori undertaken and summarise the outcomes.

Members of the EPA Māori National Network comprising 169 iwi, hapū, and Māori organisations and individuals were contacted on 9 December 2011 and invited to enter dialogue on the proposal to introduce *Anthonomus kuscheli* and *Berberidicola exaratus*. Email or written responses were received from five respondents and extracts can be found on the Landcare Research website (Landcare Research, 2012). Several submissions supported the proposal. None opposed it outright but several urged caution. Key concerns identified in submissions were:

- How can tests in Chile give us confidence that 'no native plants would be at risk here'?
- Little or no supporting documentation provided to make an informed assessment
- The threat to native flora (see Section 6.2)
- The threat to native fauna (see Section 6.2)

The mechanisms by which specialist insects choose their host plant are fixed physiologically, and cannot alter just through transfer to Aotearoa. Safety-tests to confirm this are based on the principle that for apparently host specific insects like these, the plants most likely to be susceptible to off-target attack are those most closely related to the target weed (Briese, 2005; Sheppard et al., 2005). In this case, there are no closely related native plants species because there are none in the same plant family as Darwin's barberry. The protocols used worldwide for testing the safety of weed control agents have proven to be very robust over many decades, and were adhered to in this case. The two insects in question were the subject of at least 3 years experimental and field survey work in Chile, and the results of this research are presented in Section 6.1 (Tables 1 & 2). More information is supplied on the Landcare research website (Landcare Research, 2012).

Acknowledging concerns expressed by the Ngai Tahu HSNO Komiti, Landcare Research imported populations of these two control agents into containment at Lincoln in 2012 to conduct tests on several native plants belonging to the family Ranunculaceae. These tests were limited in scope because of the time of year, but reinforced the findings from tests in Chile (see Table 3 and Section 6.1; Landcare Research, 2012).

Landcare Research has completed a retrospective study of biocontrol projects conducted in New Zealand and found that (with two minor exceptions, which led to changes in best practice) there have been no unpredicted effects of weed biocontrol in Aotearoa (Fowler et al., 2000; Paynter et al., 2004).

A number of other issues have been raised by tāngata whenua in submissions concerning previous applications to introduce biological control agents for weeds. Responses to these concerns can be found be found on the Landcare Research website (Landcare Research, 2012).

6. Identification and assessment of beneficial (positive) and adverse effects of the new organism(s)

Adverse effects include risks and costs. Beneficial or positive effects are benefits.

- Identification involves describing the potential effects that you are aware of (what might happen and how it might happen).
- Assessment involves considering the magnitude of the effect and the likelihood or probability of the effect being realised.

Consider the adverse or positive effects in the context of this application on the environment (e.g. could the organism cause any significant displacement of any native species within its natural habitat, cause any significant deterioration of natural habitats or cause significant adverse effect to New Zealand's inherent genetic diversity, or is the organism likely to cause disease, be parasitic, or become a vector for animal or plant disease?), human health and safety, the relationship of Māori to the environment, the principles of the Treaty of Waitangi, society and the community, the market economy and New Zealand's international obligations.

The potential risks, costs and benefits associated with the following were identified by literature review, by public consultation and by formal brainstorming.

1. The proposed introduction to New Zealand of *Anthonomus kuscheli* and *Berberidicola exaratus;* and
2. The possible reduction in the abundance and vigour of Darwin's barberry.

All effects identified have been tabulated on the Landcare Research website (Landcare Research, 2012). Only those considered to be potentially significant are addressed in Section 6.

6.1. Beneficial effects on the environment

Biological control of Darwin's barberry is expected to benefit the environment by:

- Causing a decline in the rate of invasion and consolidation of Darwin's barberry, and limiting reinvasion of cleared sites;
- Protecting rare and endangered species; and
- Protecting and eventually restoring native vegetation and ecosystems.

Darwin's barberry poses a threat to economic (see Section 6.6) and environmental values. The rate at which this threat builds is directly related to the amount of seed spread by birds (Section 3). *Anthonomus kuscheli* and *Berberidicola exaratus* will limit the future impact of Darwin's barberry by reducing seed production, thereby limiting the rate at which it can spread from its existing range to establish satellite populations. The most rapid pathway for the spread of barberry in New Zealand is medium to long-distance seed dispersal by birds (McAlpine & Jesson, 2008), and the establishment of satellite infestations. Acting together, the weevils are expected to reduce to low levels the amount of viable seed distributed by birds, reducing the probability of new plants establishing beneath bird perches. Biological control will limit the density of plants developing within those satellites by limiting the number of founding seeds. A benefit will accrue at any rate of attack by control agents. Darwin's barberry can also spread at the margins of infestations by passive seedfall. Massive amounts of fruit and seeds fall directly beneath barberry plants. It is unlikely that weevils will reduce seed production enough to significantly reduce marginal spread.

Given the propagule pressure and dispersal success of Darwin's barberry, McAlpine & Jesson (2008) recommended that removal of seed sources was a high priority strategy for successful Darwin's barberry management. Reducing the seed production of Darwin's barberry using these biological control agents directly addresses that priority.

These weevils will not significantly affect existing Darwin's barberry plants because:

- The damage to leaves and stems of Darwin's barberry caused by adult weevils will be trivial; and
- The larvae only attack flower buds, flowers, and/or fruits.

Any benefits to ecosystems currently infested with Darwin's barberry will only become evident in the long-term as the decline in seed production reduces the capacity of Darwin's barberry to replace itself in infested sites.

6.2. Adverse effects on the environment

The two control agents would be detrimental to the environment if weevils:

- significantly reduced native plant populations;
- significantly reduced food available to native birds;
- competed significantly with native invertebrate species;
- hybridised with native species; or
- caused replacement of Darwin's barberry with a worse weed.

Experiments to define the host range of these two weevils confirm that it is highly unlikely that *A. kuscheli* and *B. exaratus* will adversely affect the population dynamics of any native plant. Field surveys and outdoor experiments were conducted in Chile (the home range of the weed and its natural enemies) in 2009/10 and 2010/11 (Table 1 & 2; Norambuena & Escobar, 2010; Norambuena, 2011). Laboratory experiments were conducted in containment in New Zealand in 2012 (Table 3; Smith 2012). Plants to be tested were selected in accord with the well-established principle that the most likely alternative hosts for a specialist insect are those most closely related phylogenetically to the primary host (Briese, 2005; Sheppard et al., 2005).

The phylogeny of *B. darwinii* is illustrated below. The range of plants selected for testing in Chile (Table 1, 2) was influenced by several factors:

- There are only four families in the order Ranunculales represented in the New Zealand naturalised flora (http://nzflora.landcareresearch.co.nz/).
- There are no native species in the family Berberidaceae in New Zealand. The native flora is therefore not closely related to the target plant.
- The Ranunculaceae are an important part of the native flora, but no New Zealand species have fruits suitable for attack by *Berberidicola exaratus* (Webb et al., 1988).
- All New Zealand native species that form fruits resembling those of Darwin's barberry are too distantly related to Darwin's barberry to warrant testing.
- No New Zealand native species were available for testing in Chile.

Order	Families in NZ	Significant NZ genera	Comments
RANUNCULALES	Berberidaceae	*Berberis, Nandina*	No natives; weedy and ornamental *Berberis* species; 'heavenly bamboo'
	Ranunculaceae	*Clematis, Ranunculus, Anemone*	Native and ornamental *Clematis* and *Ranunculus* species; many native mountain daisies and buttercups; four other native species; non-native ornamentals such as anemone and aquilegia
	Lardizabalaceae	*Akebia, Stauntonia*	No natives; one weed; one ornamental
	Papaveraceae	*Papaver, Fumaria, Meconopsis*	No natives; ornamental poppies, some minor weeds

Many of the species tested in Chile were not available in pots (Norambuena & Escobar, 2010), and so tests were conducted at a range of field sites over two seasons. A total of 17 plant species belonging to families within the order Ranunculales were exposed to *A. kuscheli* and to *B. exaratus* (Tables 1 & 2). In accordance with the centrifugal method of Wapshere (1974; Landcare Research, 2012) greatest emphasis was given to testing other species of *Berberis* available in Chile, then species in the neighbouring sub-family, and finally species in related families within in the Order Ranunculales. There are many species of *Ranunculus* and *Clematis* in the New Zealand native flora. *Clematis montana* and *Ranunculus repens* were selected as local surrogates for New Zealand species of the family Ranunculaceae. Adult weevils were added to cloth sleeves enclosing either the flower buds (*A. kuscheli*) or the developing fruits (*B. exaratus*) of test plants. To ensure that the weevils used were reproductively active at the time of the tests, weevils were also caged with the susceptible host, Darwin's barberry (controls). The flowering time of some test species did not coincide with that of Darwin's barberry, and as the true host was not present at all sites, controls for some tests were 5–10 km distant from experiments. This meant that, by necessity, some experimental controls were not ideally placed in time or space. A conservative approach has been taken to interpretation of these data (Tables 1 & 2). Adults of both species were long-lived in tests. Plant parts in bags were examined several times through the season for damage and larval attack, and for new generation adults (*A. kuscheli*) or fallen mature larvae (*B. exaratus*). Methods and results are detailed in the reports of Norambuena & Escobar (2010) and Norambuena (2011), and are available at the Landcare Research website (Landcare Research, 2012).

Weevils were imported into New Zealand in early 2012, and were held in containment at Landcare Research, Lincoln. Additional tests on New Zealand test species were completed to enhance the data from trials in Chile. Individual weevils were placed with test plant material in petri dishes to see if they fed on those plants. Few plants had buds or fruit at that time of year, but several tests also examined the ability of weevils to lay eggs on New Zealand plants (Table 3; Smith, 2012).

This summary (Tables 1-3) and interpretation of the data contained in reports by Norambuena & Escobar (2010), Norambuena (2011) and Smith (2012) has been reviewed by Dr Q. Paynter (Landcare Research, pers.comm., see Section 9.2).

Anthonomus kuscheli

Tests in Chile - Adult weevils fed on the leaves and/or buds of *B. darwinii,* and on all other *Berberis* species (sub-family Berberidoideae), but not on foliage of *Nandina domestica* (sub-family Nandinoideae) or on four representative species of the related families Ranunculaceae, Lardizabalaceae or Papaveraceae (Table 1). Adult weevils feed on new barberry foliage, but do not attack mature leaves (L. Smith, Landcare Research; Hernán Norambuena, pers. comm., see Section 6.5).

A new generation of weevils was produced on *B. darwinii* and *B. thunbergii atropurpureum* but not on the other nine *Berberis* species presented in those tests that were well-controlled (Table 1). In fact, with the exception of *B. thunbergii*, no larvae were found in the buds of any plants other than the target weed, suggesting that no eggs were laid on those plants.

Tests in New Zealand – Adults fed actively on new foliage in Darwin's barberry controls. There was no significant feeding on the foliage or buds of the four native and four exotic New Zealand species belonging to plant families related to the Berberidaceae that were presented in tests (Table 3).

Test results indicate that there is no significant risk that *A. kuscheli* will attack plant species outside the sub-family Berberidoideae. There are no native species in the family Berberidaceae and so no native plants are at risk of damage by either adult weevils or larvae. It is possible that the foliage and buds of ornamental *Berberis* species growing in New Zealand might be damaged by adult weevils. *Berberis thunbergii* is the only host that supported complete development in tests. A damaging population of weevils might build on this host, but significant damage to other plants will only occur where the density of adult weevils on the environment is high. This is only likely in the immediate vicinity of Darwin's barberry. Dr Norambuena (pers.comm.) observed in Chile *"A. kuscheli adults punctured consistently new foliage of B. thunbergii not only in the sleeved branches or plants. The attack to new leaves was noticed also in other not enclosed plants/branches that were near to barberry infested by the weevil in the study site (Carillanca in 2009) but not flower buds were infested. Further, no weevils or damaged flower buds were found in thunbergii atrop.in front and backyards and in public areas."* The significance of possible attack on *B. thunbergii* is discussed further in Section 6.7.

Berberidicola exaratus

Tests in Chile - Mature larvae of *B. exaratus* normally emerge from Darwin's barberry fruit and fall to the ground to pupate and complete development (Section 4.2). Finding dead larvae suspended in the cloth bags surrounding test plant foliage was taken as evidence of complete development on that host. Such larvae were found in seven of the eight *Berberis* species (subfamily Berberidoideae) in 'well-controlled' tests (Table 2). However, there was no sign of larval development on *Nandina domestica* (subfamily Nandinoideae), or on more distantly related plant species outside the family Berberidaceae. Similarly, adults fed on the leaves and particularly the fruits of most *Berberis* spp. presented, but not on *N. domestica* or on species from other families in the order Ranunculales (Table 2).

Tests in New Zealand – Only three test plants were fruiting at the time of these tests. Fruits of *Berberis glaucocarpa* (a common hedge plant and weed in New Zealand) exposed to weevils were readily attacked and produced larvae. No attack was observed on the native *Clematis paniculata* or on the Asian species *Nandina domestica.* As in Chile, adults did not feed significantly on the foliage of the seven species outside the sub-family Berberidoideae that were tested (Table 3).

From these results we conclude that *Berberidicola exaratus* is able to complete development on several species within the genus *Berberis* and is not specific to Darwin's barberry. However, is unlikely to attack species outside the subfamily Berberidoideae, or reproduce on any New Zealand native plant species because:

- Species of the genus *Berberidicola* are only known to attack *Berberis* species;
- *Berberidicola exaratus* deposits eggs into feeding scars it creates on fruits. If there is no feeding on fruits, no eggs can be laid;
- Species of the Ranunculaceae, the only family in the New Zealand native flora in the same order as Darwin's barberry, do not have the fruits necessary for larval development of *B. exaratus* (Webb et al., 1988; P. Williams, pers. comm.); and
- The species in the native flora that have fruits are only very distantly related to *Berberis.*

Although no native plants will be attacked, it is possible that the foliage and buds of exotic species of *Berberis* may be slightly damaged by adult weevils (see Section 6.5).

Approximately 50% of all Darwin’s barberry flowers mature to form fruits, and production can exceed 4,000 fruits per m^2 (Allen & Wilson, 1992). Allen & Wilson found that birds consumed 74% of Darwin’s barberry fruits in one year and 77% in another. *Berberidicola exaratus* feeds on seeds within fruits. It may change the quality of fruits as food for birds, but would not affect the number of fruits available. *Anthonomus kuscheli* is expected to reduce flowering and hence the number of fruits produced by Darwin’s barberry. Reduction of this food source could be detrimental to bird populations if Darwin’s barberry was a critical food source. This is considered unlikely because:

- Allen & Lee (2001) record that bellbirds do not appear to be major consumers, and that most Darwin’s barberry seeds in the south of New Zealand are dispersed by blackbirds, thrushes and silvereyes.
- Williams & Karl (1996) found that tui did not consume the fruits of *Berberis glaucocarpa*, and stated that while silvereyes eat *Berberis* fruits, a wide range of alternative fleshy fruits are also consumed.
- It is not recorded as a crucial item in the current diet of any native bird.
- Darwin’s barberry is not yet abundant in most parts of New Zealand. It cannot be a key food source where it spatially uncommon.

The introduced weevils could theoretically compete directly with native invertebrate species for food or space, or compete indirectly through the sharing of natural enemies (apparent competition). No effects to native invertebrate populations are expected to be significant because:

- Smith et al. (2004) completed a survey of the flora and fauna already associated with *Berberis* species in New Zealand. Thirty herbivorous invertebrates were found on *B. darwinii*, mostly generalists for which barberry was one of many potential hosts. Only one (exotic) species was abundant and the overall damage attributable to herbivore damage was minimal. That means that Darwin's barberry is not used significantly by native species, and so there appears to be no real opportunity for *A. kuscheli* or *B. exaratus* to compete directly with native arthropods for resources on this host plant.

- As these weevils can only reproduce on *Berberis* species, eggs and larvae will only be found inside plant parts of barberry species, well hidden from those parasitoids or predators of native weevils that are not adapted to finding hosts within such structures.
- Free-living adult weevils will augment the prey pool available to generalist predators, although such predators are not common on Darwin's barberry (Smith et al., 2004). Adult weevils will be uncommon prey except on barberry species. Similarly, adult weevils could be an additional host for parasitoids such as *Microctonus aethiopoides* providing apparent competition for other native weevils (B. Barratt, AgResearch, pers. comm.) but this could only be significant where *A. kuscheli* and *B. exaratus* are common.
- Any direct or indirect effects on native species will be restricted to where the weevils are present and abundant. As these weevils can only reproduce on *Berberis* species, this will only be true in the immediate vicinity of *Berberis* plants. These plants are not yet abundant at a landscape scale in New Zealand.

Hybridisation with native species is not possible because there are no native *Anthonomus* or *Berberidicola* species amongst the native fauna (Section 4.3).

The primary purpose of this proposal is to limit the spread of Darwin’s barberry. Feeding on foliage by *Berberidicola exaratus* and *Anthonomus kuscheli* adults is likely to be trivial, and will not affect the growth or survival of Darwin’s barberry plants. Plants can survive for 30 years (Allen & Lee, 2001). If biological control reduced seed production sufficiently to stop Darwin's barberry replacing itself within existing stands, then populations could decline.

6.3. Beneficial and adverse effects on human health

No significant beneficial or adverse effects were identified.

6.4. Beneficial effects on society and communities

The introduction of *Berberidicola exaratus* would benefit society and communities if it reduced the potential weediness of other *Berberis* species in New Zealand. *Berberis glaucocarpa* has been widely planted in New Zealand for hedging, and in many areas has spread out of control (Roy et al., 2004). *Berberidicola exaratus* is not specific to Darwin’s barberry (see Section 6.2), and attacked *B. glaucocarpa* fruits in the laboratory (Table 3; Smith, 2012). *Berberis vulgaris* is common in Canterbury and Otago (Webb et al., 1988). *Berberidicola exaratus* may restrict seed production and dispersal of these emerging weeds, but this effect is uncertain.

B*erberis thunbergi* is regarded as a weed in USA and is naturalised in Australia (ISSG, no date). It is a potential future weed in New Zealand but has not yet naturalised here. This species may be susceptible to both agents (see Sections 6.2 and 6.5).

6.5. Adverse effects on society and communities

Berberis species produce abundant colourful flowers and berries, and species such as *B. japonica* and *B. aquifolium* (holly grapes) are well known ornamentals in New Zealand gardens. *Berberis thunbergii* cultivars are valued more for their variously coloured foliage than for their flowers. Introduction of these weevils would adversely affect community well-being if it caused:

- Significant non-target effects on ornamental barberry species
- Fear and distrust of biological control introductions.

Neither A. *kuscheli* nor *B. exaratus* is expected to significantly affect the utility of barberry species as ornamentals for the following reasons.

Anthonomus kuscheli

With the exception of *B. thunbergii*, *A. kuscheli* could not complete development on any of the *Berberis* species presented in tests (see Section 6.2). It is therefore unlikely that damaging populations of *A. kuscheli* will ever build on those plants. Adults fed on the foliage or buds of *Berberis* species other than Darwin's barberry in tests, but because adults will be rare, feeding blemishes on foliage and flower buds sufficient to significantly reduce the aesthetic appeal of those ornamentals will be rare. However, *A. kuscheli* completed development on buds of *B. thunbergii* and adults punctured foliage and flower buds (see Section 6.2). Overall this means that:

- Populations of *A. kuscheli* could build on large stands of *B. thunbergii;*
- The intensity of flowering of *B. thunbergii* could be reduced because larvae destroy flower buds;
- Adult *A. kuscheli* could cause minor damage to foliage, especially new spring growth;
- Significant populations of adults will not occur on other non-target barberry plants;
- Feeding damage to other non-target *Berberis* plants caused by adult weevils should not therefore significantly reduce ornamental value (except possibly in the vicinity of Darwin's barberry);
- The flower buds and foliage of other valued *Berberis* species will be immune from larval attack in New Zealand, and flowering intensity of these species will not be significantly affected.

Given the resistance of other *Berberis* species to *Anthonomus* attack, the production of a new generation of weevils on this cultivar of *B. thunbergii* in caged tests was anomalous and may reflect heavy selection for ornamental values (see Section 6.6). It is nevertheless a real result. Observations in Chile suggest that isolated plants of *B. thunbergii* do not sustain damage (H. Norambuena, pers. comm., see Section 6.2) but weevils were observed on this species in the vicinity of Darwin's barberry. In New Zealand that proximity will be exceedingly rare.

Specimen ornamentals could be protected from attack by the application of insecticide in spring.

Berberidicola exaratus

Berberidicola exaratus can complete larval development on a range of *Berberis* species (Section 6.2), and we assume that all *Berberis* species in New Zealand will be hosts. Adult weevils are only 3mm in length, and individuals feed only a little on foliage. In the worst scenario:

- Nibbling on the foliage and flower buds by adults may reduce the aesthetic value of ornamental barberry species slightly (see Section 6.2), but not enough to threaten plant health or utility;
- The aesthetic value of barberry berries will not be affected because the larvae of this weevil feed within the fruits hanging on bushes (see Section 3); and

- The collection of seeds for propagation of valued species will become more difficult because many (but not all) of the seeds of valued *Berberis* spp. are likely be destroyed by larvae (Section 6.7). Increased costs of collection are unlikely to be a significant increased burden to the nursery industry.

Seed sources and ornamental specimens could be protected from attack using insecticides.

There is a firmly held view amongst some members of the community that the introduction of any exotic organism is detrimental to the ecological, spiritual and/or cultural integrity of New Zealand (see also Section 5). The applicants contend that as these weevils are restricted to barberry species, their ecological footprint is small, and that the benefits to the New Zealand environment and community through management of the future damage of Darwin's barberry outweigh any such adverse cultural effects.
The control agents will not significantly damage Darwin's barberry plants already growing in New Zealand. Their introduction will not reduce employment associated with existing pest management programmes.

6.6. Beneficial effects on the market economy

Biological control of Darwin's barberry would benefit the market economy by:

- Reduced or more efficient investment by DOC, Regional Councils and land occupiers to mitigate the effects of Darwin's barberry;
- Limitation of future invasion of pastoral land; and/or
- Restoration of productive values on infested pastoral land.

Berberidicola exaratus and *Anthonomus kuscheli* feed on the reproductive structures of Darwin's barberry and cannot influence the survival of extant infestations. However, reduction of seed production by these insects is expected to:

- Limit the rate at which satellite populations establish (see Section 6.1).
- Limit the rate at which investment in Darwin's barberry must increase to maintain biodiversity and production values.
- Increase the effectiveness of current investment by limiting reinvasion of cleared sites.

The distribution of Darwin's barberry is still limited. Without intervention it is expected to continue moving into suitable habitats as time passes. Invasion poses a clear and present threat to biodiversity and pastoral production values in New Zealand. The importance of this threat is reflected in the current investment by institutions in Darwin's barberry management. It is included in the Regional Pest Management Strategies (RPMS) of ten councils (MAF, 2012), and the considerable costs of complying with those strategies fall to regional ratepayers and land occupiers. No attempt has been made to sum the monetary cost of Darwin's barberry nationally, but supporting information has been received from eight regional or unitary councils (Landcare Research, 2012) and some of this is presented here. Five of the strategies specify the maintenance of biodiversity values, or the integrity of high value natural areas as a priority, often in collaboration with DOC. Several strategies propose eradication of this weed from all or part of their region. Most require Darwin's barberry to be contained within existing distributions, and the responsibility for containment falls largely on the occupiers of infested land, and agencies such as road authorities (road verges) and DOC (boundaries).

- Darwin's barberry is not present or is not seen as a threat north of Waikato. Without containment, the Net Present Value (NPV) of production losses and the additional costs of control over 50 years in the Waikato Region is estimated to exceed $1.2 million, and on 21,738 ha there would be additional damages to regionally significant conservation, amenity, Maori, and/or soil and water values (Waikato Regional Council, 2007).
- The cost benefit analysis for the RPMS of Horizons Regional Council states that 3,340 ha of land is currently infested within the region, but 884,000 ha is at risk, including 322,000 ha of conservation value (Horizons, 2006).
- *'It is particularly bad in the western hills of the Wellington suburbs, spreading from Karori Cemetery south across the retired regenerating hill country to the coast, north to Mt Kaukau and encroaching on the productive farmland of the Ohariu Valley. It is also spreading in the Hutt and Whiteman's Valleys and at sites in the Wairarapa….Seeds are spread by birds, and with both exotic and native bird populations increasing from widespread possum and rat control in the region, the spread is becoming worse' (Davor Bejakovich, GWRC).*
- *'It is present in areas around coastal areas of Dunedin City in varying degrees including the Otago Peninsula. In North, East and Central Otago it is believed that in large, it has not established or certainly not common and not yet established to any extent. An area in the Queenstown Lakes District where it is known to exist is in the Glenorchy area' (Richard Lord, Otago Regional Council).*
- The NPV of containment to avoid decline in conservation and biodiversity values in the Southland Region would be $792,000 (Harris, 2006).

Darwin's barberry is of concern to DOC in conservancies in both North and South Islands, but is a particular threat to the forest and shrubland of Rakiura National Park. In October 2001, a multi-agency eradication programme involving Southland District Council, Environment Southland and DOC joined forces to eradicate Darwin's barberry from Stewart Island. In 2006, this control programme covered 1,200 ha, and cost approximately $112,000. Without regional intervention under the RPMS, the infestation in Stewart Island could eventually reach 127,000 ha (Harris, 2006).

Darwin's barberry is a difficult and expensive weed to control.

'It requires high rates of herbicide and penetrant to successfully poison with spray, and is difficult to target because it is commonly found amongst regenerating native. Cutting and stump treating is very labour intensive, with hard stems, sharp vegetation and the plant growing in dense thickets

It took ten man days to cut and stump treat 800 sq m of barberry mixed in with regenerating native. Less than 2 kg of vigilant gel was used in the two days, indicating the difficulty of the vegetation and the task.

Another site of 3.3 ha was controlled by cutting and stump treating. This took 37 man days during which 5125 trees, saplings and seedlings were destroyed. Almost 11 kg of herbicide was applied, with some of the seedlings pulled by hand.' (Davor Bejakovich, GWRC).

It is very difficult to isolate the costs to DOC of Darwin's barberry management from general pest management expenditure, except through concrete examples provided by DOC staff:

'He reported finding 888 flowering plants (185 more than the previous year) consisting of 294 large, 364 medium and 228 small flowering plants. The control operation used 6 people for 3 weeks so an intensive effort.'

'We are undertaking Barberry control at a number of sites around the area but the major site is the Blue Mountains. This work is a major and if we had the budget could soak up a lot of money. There is a lot of barberry on private land in this area and while some farmers are doing control work there are a lot that aren't. At the moment DOC Murihiku is spending $10,000 a year at different sites in this area, this is mainly just holding ground and trying to stop its spread.'

Darwin's barberry has invaded pastoral land in the lower North Island, and from South Canterbury to Southland (see illustration) where it is said to act in a similar manner to gorse. It is not known what area of land has already been removed from production, or what pastoral production is currently foregone. While the problem for pastoral agriculture is currently local and patchy, the potential for further invasion by Darwin's barberry is clear. Local variation in the importance of Darwin's barberry to pastoral production is reflected in the comments from two Southland farmers, one of whom stated '*I know DB (not the beer) is a real issue*', but another said '*A couple of scrub cutters and chainsaws would have this problem sorted by lunchtime with the afternoon to paint the stumps with 'Round up''* (Mark Ross, Federated Farmers, pers. comm.).

Darwin's barberry is present in approximately 1% of QEII National Trust covenants in New Zealand, but in 6% of those in the Wellington Region. It is controlled in some covenants, but the overall severity is not well recorded (Tom Barber, QEII National Trust, pers. comm.).

Berberidicola exaratus and *Anthonomus kuscheli* are not expected to have a significant impact on the vigour or survival of Darwin's barberry plants already growing on pastoral land in New Zealand. In the short term their introduction alone cannot restore land that is already infested. However, reducing the risk of reinvasion may make investment in conventional management of Darwin's barberry more viable.

6.7. Adverse effects on the market economy

Biological control of Darwin's barberry would adversely affect the market economy if there was significant:

- Reduction in strategic spring resource for bees
- Increased cost of replacing garden ornamentals
- Increase in control expenditure by organisations
- Increased costs of managing non-target impacts.

Beekeepers value plants that flower in early spring because these provide the pollen required to increase the number of bees available to exploit nectar flows later in the season. *Berberis glaucocarpa* flowers in early spring. Darwin's barberry flowers from January to December, and is less valuable because other plants such as clover are flowering abundantly by then. *Berberidicola exaratus* feeds on fruits and is not expected to significantly affect flower production (see Section 6.5). *Anthonomus kuscheli* is expected to reduce the flowering of Darwin's barberry and so this adverse effect is real; however, it is not expected to significantly decrease the national value of barberry species because:

- Dense infestations of Darwin's barberry remain of limited distribution in New Zealand, and can be of significant value for hive health and honey production only in those areas. Any effect is likely to be localised to Southland and South Canterbury;
- Barberry species such as *B. glaucoparpa* and *B. vulgaris* that are more widely distributed in New Zealand are likely to be more important to the beekeeping industry than Darwin's barberry;
- Test results suggest that *A. kuscheli* is unlikely to attack *B. glaucocarpa* or *B. vulgaris* (see Section 6.2).
- Darwin's barberry flowers when other floral sources are available to compensate for losses; and
- With the exception of *B. thunbergii* plants in gardens, flowering of other *Berberis* species is not likely to be affected by these control agents (see Section 6.5).

Except for *B. thunbergii, Berberidicola exaratus* and *Anthonomus kuscheli* will not significantly affect the survival or the ornamental value of garden *Berberis* species (Section 6.5). It is unlikely that the activity of these control agents will lead to replacement.

The prospect of future control of Darwin's barberry by *A. kuscheli* and *B. exaratus* could lead to increased investment in the management of extant infestations. Increased cost to the market economy would be offset by the ecological and economic benefits of that investment.

The applicant concludes that none of the possible non-target effects discussed in Section 6 is significant, and none would require significant monetary compensation.

7. Could your organism(s) undergo rapid assessment?

If your application involves a new organism that is or is contained within a veterinary or human medicine, could your organism undergo rapid assessment (s38I of the HSNO Act)?

Describe the controls you propose to mitigate potential risks (if any). Discuss what controls may be imposed under the ACVM Act (for veterinary medicines) or the Medicines Act (for human medicines).

Discuss if it is highly improbable (after taking into account controls if any):

- the doses and routes of administration of the medicine would have significant adverse effects on the health of the public or any valued species; and
- the organism could form an undesirable self-sustaining population and have significant adverse effects on the health and safety of the public, any valued species, natural habitats or the environment.

Do not include effects of the medicine or new organism on the person or animal being treated with the medicine.

Not Applicable

If your application involves a new organism (excluding genetically modified organisms), could your organism undergo rapid assessment (s35 of the HSNO Act)?

Discuss if your organism is an unwanted organism as defined in the Biosecurity Act 1993.

Discuss if it is highly improbable that the organism after release:

- could form self-sustaining populations anywhere in New Zealand (taking into account the ease of eradication)
- could displace or reduce a valued species
- could cause deterioration of natural habitats,
- will be disease-causing or be a parasite, or be a vector or reservoir for human, animal, or plant disease

- will have adverse effects on human health and safety or the environment.

Not Applicable

8. Other information

Add here any further information you wish to include in this application including if there are any ethical considerations that you are aware of in relation to your application.

There are no ethical considerations to be addressed.

8.1. Section 36 minimum standards

This proposal does not contravene the Minimum Standards set out in Section 36 of the HSNO Act 1996:

- The risk of displacement of native plants is negligible. No native plants will be subject to attack by these control agents (Section 6.2). There are no native insects commonly associated with Darwin's barberry that could be directly displaced (Smith et al., 2004), and any more complex interactions, such as apparent competition, would only occur in the immediate vicinity of Darwin's barberry infestations.
- The control agents will not influence current infestations of Darwin's barberry and cannot cause deterioration of natural habitats.
- No mechanism for adverse effects on human health and safety has been identified.
- There are no representatives of either genus resident in New Zealand. These species are only distantly related to any native weevils and there is no possibility of hybridisation or adverse effect on inherent genetic diversity.
- Both agents are specific to *Berberis* species and there is negligible risk that either could vector diseases outside this genus.

8.2. Post-release monitoring and measurement of impact

Landcare Research will provide releases of these weevils to other organisations and oversee their follow up. It is their practice to monitor release sites for the establishment of all biological control agents. If these weevils become abundant, Landcare Research will undertake measurement of their effects. The methodology will be considered only once establishment is confirmed, and rational research plans can be developed.

9. Appendices(s) and referenced material (if any) and glossary (if required)

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9.2 Review report

I have reviewed the information presented in two reports written by Dr Hernàn Norambuena and co-authors (including a “missing table” that was omitted from the original 2010 report), the results of additional tests conducted by Lindsay Smith in containment at Landcare Research, Lincoln and the summary reports and tables written by Dr Richard Hill. I have addressed Richard Hill’s following questions:

1. Is Dr Norambuena’s research appropriate for the estimation of the host range of these two weevils?
2. Do my tables accurately summarise the data provided in the reports?
3. Do you have any comments about the research conducted earlier this year in containment at Lincoln?
4. Is my table 3 an accurate summary of Lindsay’s data?
5. I attach text for the draft application to introduce these two weevils. Is this text a fair interpretation of the data presented in my tables 1-3?

The first of Dr Norambuena’s reports (2010) covers no-choice testing of both agents in 2009/10 and a field survey to determine their host-ranges in the field; the second (2011) report covers no-choice tests conducted in 2010/11. The experiments performed by Dr Norambuena are appropriate although both of these reports are difficult to follow in places. I think Richard has done an admirable job of encapsulating the information in his summary tables which, in my opinion, do reflect the content of the reports accurately.

The main difficulty when interpreting the results is due to the lack of synchrony between the period of flowering and seed-set of the host plant *Berberis darwinii* and some of the test plant species. Where such asynchronies occur, Richard’s interpretations of the reports are conservative. For example, Richard lists *Eschscholzia californica* as an uncertain host for *Anthonomus kuscheli* because testing of this species commenced c. 1 month after the *B. darwinii* controls (so the negative result might be due to the beetles being no longer reproductively active, rather than *E. californica* being an unsuitable host plant). However, the *Eschscholzia californica* test was performed only 2 weeks after a test involving *Berberis thunbergii*, which did support larval development. Moreover, although only two *Berberis* spp. supported *A. kuscheli* larval development, all but *B. japonica* were fed on by adult weevils. The absence of adult feeding on *E. californica*, therefore, strongly suggests to me that *E. californica* is less likely to be a host plant of *A. kuscheli* than the *Berberis* spp. that were not oviposited upon. Under natural conditions, adult insects that feed on the buds and foliage of their host plants are unlikely to oviposit on plants that they do not feed on.

The additional tests performed in Lincoln are summarized correctly in Richard’s Table 3. They again provide strong supporting evidence that both weevils are unlikely to attack valued non-target plants in New Zealand.
Bar a couple of minor comments (see attached file), the text for the draft application to introduce these two weevils is fine. The text is a fair interpretation of the data presented in Richard’s tables 1-3.

I hope this review is what you require - I wasn't sure how much detail you require, so I am happy to provide further information should anything need clarification.

Dr Quentin Paynter

Manaaki Whenua Landcare Research

Private Bag 92170

Auckland

New Zealand

10. Signature of applicant or person authorised to sign on behalf of applicant

☐ I request the Authority to waive any legislative information requirements (i.e. concerning the information that shall be supplied in my application) that my application does not meet (tick if applicable).

I have completed this application to the best of my ability and, as far as I am aware, the information I have provided in this application form is correct.

Signature	**Date**

Table 1. 'No choice' tests conducted in Chile (Norambuena & Escobar 2010; Norambuena 2011) to test whether *Berberidicola exaratus* feeds on foliage, creates feeding scars (oviposition sites), on fruits and/or produces growing larvae in fruits and seeds. No feeding on fruits implies that adults did not create oviposition sites, and that this plant is not suitable host for larval development. Successful development implies that adults damaged fruits (- = no test undertaken, not recorded, or no conclusion can be drawn from data).

Family Subfamily	Species	Year	No. of Tests	Tests yielding larvae	Reps where adults fed on fruits	Adults feed on foliage	Likely suitable host?	Control
Berberidaceae Berberidoideae	*Berberis darwinii*	2009/10	6	4	6	-	Yes	Curileo
		2010/11	7	6	7	-	Yes	Chile, 3 sites and 5 dates
	Berberis congestiflora	2009/10	6	4	3	No	Yes	Self-controlled
	Berberis valdiviana	2009/10	5	2	5	-	Yes	Self-controlled
	Berberis microphylla	2009/10	5+3	2	8	Yes	Yes	*B. valdiviana*
	Berberis empetrifolia	2010/11	6	0	0	No	No	Associated control
	Berberis negeriana	2009/10	4+4	1+0	8	-	Uncertain	No, only test at site
	Betrberis trigona	2010/11	5	1	2	No	Yes	Associated control
	Berberis serratodentata	2009/10	6	2	6	Yes	Yes	Self-controlled
	Berberis aquifolium	2009/10	6	3	6	No	Yes	Self-controlled
	Berberis wilsoniae	2010/11	4	0	4	No	Uncertain	No, conducted across seasons
	Berberis thunbergii atr	2009/10	3+4	0+1	7	Yes	Yes	*B. valdiviana*, and self-controlled
	Berberis japonica	2009/10	5	0	5	Yes	Uncertain	No, tested earlier than other plants
Nandinoideae	*Nandina domestica*	2010/11	4+3	0+0	0	-	No	Associated control
Ranunculaceae	*Clematis montana*	2010/11	7	0	0	No	No	Control set up 3 days earlier
	Eschscholzia californica	2010/11	6	0	0	No	Uncertain	Set up 1 month after control
	Ranunculus repens	2010/11	6	0	0	No	No	Associated control
Lardizabalaceae	*Boquila trifoliolata*	2009/10	9	0	0	-	Uncertain	10 km from *B. aquifolium* control
Papaveraceae	*Papaver rhoeas*	2009/10	5	0	0	No	No	*B. aquifolium*

Table 2. 'No choice' tests conducted in Chile in 2009/10 and 2010/11 to test whether *Anthonomus kuscheli* feeds on foliage or produces larvae in flower buds (- = no test undertaken, not recorded, or no conclusion can be drawn from data) (Norambuena & Escobar 2010; Norambuena 2011).

Family Subfamily	Species	No. of tests	Tests yield larvae	Adults feed on flower buds	Adults feed on foliage	Likely suitable host?	Control
Berberidaceae	*Berberis darwinii*	6	2	Yes	Yes	Yes	Control 1. Carillanca 25 Sep 09 heavy bud loss
Berberidoideae		6	4	Yes	Yes	Yes	Control 2. Curileo 1 Oct 09.
		5	5	Yes	Yes	Yes	Control 3. Curileo 23 Sep 10
		1	1	Yes	Yes	Yes	Control 4. Caramavida 19 Sep 10
		1	1	Yes	Yes	Yes	Control 5. Icalma 14 Oct 10
		2	2	Yes	Yes	Yes	Control 6. Voipir 25 Sep 10
	Berberis congestiflora	5 + 6	0 + 0	Yes	Yes	Uncertain	No, test began 14 days after control 1 + No
	Berberis valdiviana	5	0	Yes	No	No	Yes, test began 8 days before control 3
	Berberis microphylla	5	0	Yes	Yes	No	Yes, test began 3 days after control 1
	Berberis empetrifolia	4 + 1	0 + 0	Yes	Yes	Uncertain	No, began one month after control
	Berberis negeriana	5	0	Yes	Yes	No	Yes, control 4
	Betrberis trigona	6 + 6 + 5	0 + 0+ 0	Yes	Yes	No	Yes, test began 3 d after control 1 + No + No, 13 d after control 3
	Berberis serratodentata	6 + 5	0 + 0	Yes	No	No	Yes, tests began 10 days after control 1 + control 5
	Berberis aquifolium	5 + 4	0 + 0	Yes	Yes	No	Yes, control 1 + No, test began 15 days before control 3
	Berberis japonica	5	0	No	No	No	Yes, test began 8 days before control 3
	Berberis wilsoniae	8 + 6	0	Yes	Yes	Uncertain	No, tests began 8 & 20 Jan 10
	Berberis thunbergii atr	6 + 5	0 + 4	Yes	Yes	Yes	No + self-controlled
Nandinoideae	*Nandina domestica*	7	0	No	No	Uncertain	No, test began 6 Nov 09, too long after control
Ranunculaceae	*Clematis montana*	3 + 3 + 6	0 + 0 + 0	No	No	No	Yes, test began 10 days after control 1 + No + No
	Eschscholzia californica	5	0	No	No	Uncertain	No, test began 23Oct 09
	Ranunculus repens	6 + 6	0	No	No	Uncertain	No, tests began 9 Oct, 24 Dec 09
Lardizabalaceae	*Boquila trifoliolata*	5	0	No	No	No	Yes, control 6
Papaveraceae	*Papaver rhoeas*	4 + 2	0	No	No	Uncertain	No associated control

Table 3. 'No Choice' tests conducted in containment at Lincoln, New Zealand in 2012 to test whether adult *Berberidicola exaratus* and *Anthonomus kuscheli* could feed on the foliage, flower buds or fruits of selected New Zealand plants (- = no test undertaken, not recorded, or no conclusion can be drawn from data).

Family Subfamily	Species	No. of tests	Tests yielding larvae	Adults feed on foliage	Adults feed on fruits **	Adequate independent control	Likely suitable host	Notes
B. exaratus								
Berberidaceae Berberidoideae	*Berberis darwinii*	5 + 5	-	Yes	Yes	---	Yes	Feeding in all tests
	Berberis glaucocarpa	1 + 2	1	Trace	Yes	Yes	Yes	Larvae have been observed in fruits
Nandinoideae	*Nandina domestica*	1 + 1	-	No	No	Yes	No	No feeding on fruits
Rancunculaceae	*Clematis forsteri*	1	-	No	-	Yes	-	
	Clematis paniculata	2 + 3	-	No	No	Yes	No	No feeding on achenes
	Anemone hupehensis var	1	-	Trace	-	Yes	-	Trace feeding on foliage by one adult
	Ranunculus reflexus	1	-	No	-	Yes	-	
	Ranunculus new sp.	2	-	No	-	Yes	-	
Lardizarbalaceae	*Stauntonia hexaphylla*	1	-	No	-	Yes	-	

Family Subfamily	Species	No. of tests	Tests yielding larvae	Adults feed on foliage?	Adults feed on Buds	Adequate independent control?	Likely suitable host	
An. kuscheli								
Berberidaceae Berberidoideae	*Berberis darwinii*	5 + 1	-	Yes	Yes	---	-	Minor to moderate damage to leaves, half of flower buds punctured
	Berberis glaucocarpa	1	-	Trace	-	Yes	-	Minor leaf damage by one weevil
Nandinoideae	*Nandina domestica*	1 + 1	-	Trace	No	Yes	No	Minor leaf damage by two weevils no feeding on flower buds
Rancunculaceae	*Clematis forsteri*	1	-	No	-	Yes	-	
	Clematis paniculata	2	-	No	-	Yes	-	
	Anemone hupehensis var	1 + 1	-	No	No	Yes	No	No feeding on flower buds
	Ranunculus reflexus	1	-	No	-	Yes	-	
	Ranunculus new sp.	2	-	No	-	Yes	-	
Lardizarbalaceae	*Stauntonia hexaphylla*	1	-	No	-	Yes	-	