Applicant Response to Submissions

APP201363 - To import and release two weevils, *Anthonomus kuscheli* and *Berberidicola exaratus*, as biological control agents for the weed Darwin's barberry (*Berberis darwinii*).

Submission 102575 Marlborough Regional Council
No additional comment

Submission 102576 West Coast Regional Council
No additional comment

Submission 102577 Bay of Plenty Regional Council
No additional comment

Submission 102578 Nursery and Garden Industry Association of NZ
As science advisors to the applicant, Landcare Research acknowledges that consultation with NGIA was not pursued as it should have been. The issues now raised by the NGIA were foreseeable, and with the responses provided here, should have been the subject of dialogue before the application was submitted.

The responses to specific points are as follows:
'The Nursery and Garden Industry Association NGIA believes that host testing is incomplete. Host testing must include all species and cultivars of the family Berberidaceae (including but not limited to Berberis, Epimedium and Mahonia) grown by the industry for the purpose of ornamental, amenity and shelter purposes.'
Kim et al. (2004) showed that the compound-leaved *Berberis* species previously included in the genus *Mahonia* are non-monophyletic and should be included in the genus *Berberis. Mahonia* is no longer considered a distinct genus. Two species of holly grape formerly included in Mahonia were tested – *Berberis aquifolium* and *B. japonica.*

As outlined in the application, biological control of weeds theory indicates that the plant species most closely related to the primary host of a weevil are the mostly likely to be attacked. In this case, *Berberis* belongs to the sub-family Berberidoideae, while all other species in the family (with one exception - a species that does not occur in New Zealand) belong to other subfamilies and are not closely related to Darwin's barberry. It is not necessary to test every species of interest to obtain a reliable estimate of the agent's host range.

Anthonomus kuscheli adults did not feed on foliage of *Nandina domestica* (sub-family Nandinoideae), or on more distantly related plant species. The host-range testing indicates that *A. kuscheli* is host-specific to the genus *Berberis*. *Epimedium* is distantly related to Darwin's barberry and is unlikely to support *A. kuscheli* larval development.

'What an entomologist seeking biocontrol might describe as 'not feeding significantly' may….damage…result in additional costs…impacting on product quality, control costs, and gardener's perspectives….
…possible removal.. of … chemicals…leave the industry and gardeners …with another pest.
New generation of beetles on … B. thunbergii atropurpureum…B. thunbergii is not an exception….
…effects on ornamentals.. not given the weighting it should have.. Does not support the contention ..(that biocontrol won't significantly affect the utility of ornamentals)'
The adults of both weevils have minute mouthparts at the end of the proboscis and cannot destroy foliage by gross feeding. Feeding makes small brown specks on plant parts (see photo below. For scale, note that the weevil is 3 mm long). Norambuena described this damage as 'puncturing'. The applicant's view (though not discussed with

the NGIA) is that feeding by adult weevils would not adversely affect the health of plants. Damage would be barely noticeable unless a large number of adult weevils were feeding. This is unlikely. *B. exaratus* adults fed little on foliage in tests, even on Darwin's barberry, and are

unlikely to be the cause of aesthetic damage to ornamental foliage or flowers. They feed on new fruits, creating small scars (see photos below). The fruits develop normally on the tree and larvae develop within them, emerging from mature fruits once they fall from the plant. Feeding damage is barely visible on maturing fruits (see photo) and will not significantly affect the ornamental value of fruits hanging on plants.

*Anthonomus kuscheli a*dults can feed on the foliage and buds of many species within the Berberidoideae subfamily. However, adult weevils would be rare on non-target barberries because they cannot reproduce on any of the species tested (except *B. thunbergii*), and so populations would not build locally. Damage to non-target plants would only occur in very close proximity to a true host such as Darwin's barberry, and then only if weevils migrated to the ornamental.

In the case of *B. thunbergii,* weevils bagged on stems successfully completed development in buds. This raises the possibility of resident populations on this host but it is questionable whether significant populations of *A. kuscheli* could persist on isolated or massed *B. thunbergii* plants because:

1. Unlike leafy Darwin's barberry, *B. thunbergii* is deciduous, and would be less suitable as an overwintering site for adult weevils
2. *A. kuscheli* becomes reproductive in August when Darwin's barberry sets buds. *B. thunbergii* sets buds in around October. It is unlikely that reproductive adults would remain (or even survive) on *B. thunbergii* long enough to inhabit buds. There is a discontinuity in the life history.
3. *A. kuscheli* is bivoltine, so the next generation could migrate to infest buds, but only if a large source of adults (Darwin's barberry) existed nearby.

Any pesticide (including organic materials such as pyrethrum) applied in early spring would eliminate any risk of marking by killing adult weevils of either species.

'Berberidicola …is not specific to Darwin's barberry.'
When confined on branches, weevil larvae infested the fruits of a range of *Berberis* species. The applicant has assumed that some seed of susceptible *Berberis* species will always escape attack by *B. exaratus* and be available for propagation if required. To assure a large seed crop may require one annual application of pesticide to seed source trees. This weevil may reduce seed production of *B. thunbergii* f. *atropurpurea* to the point where it never becomes a weed in New Zealand, as the parent genotype has in the USA http://plants.usda.gov/java/profile?symbol=beth .

See comments above about the risk posed by adult *B. exaratus.*

NGIA is concerned about the statement (in the application) that "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". This statement coupled with careful spin in a supporting report that states "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 adults only laid eggs on B. darwinii. "
The wording of the application was carefully chosen throughout so that no conclusions were drawn that could not be supported by the evidence presented.

Submission 102581 Dr Cliff Mason
'The introduction of an alien organism..damages…environmental integrity.'
The New Zealand biota has never been, and is not physically and biologically isolated. Rather it is a dynamic, ever-changing system with species coming and going, ebbing and flowing, as much through natural processes as through human activity. Anthropogenic changes have intensified more recently, and the resulting threat from invasive weeds is grave.

'Little evidence…will yield benefit….
Unaware of any theoretical underpinning of the notion that BCAs can reduce spread.
Assumption that …sufficient to reduce colonization to a significant degree. '
It is unlikely that biological control will limit the ultimate geographical range of Darwin's barberry in New Zealand (this was not a claim made in the application). The purpose is to reduce the rate at which that distribution is achieved, and the final equilibrium density of the weed.

The potential for a weed to invade areas where it is currently absent will be limited by the number of propagules (e.g. seeds) reaching these areas. Therefore, reducing seed set has the potential to reduce the rate at which weed can invade. This has been demonstrated in the field (e.g. Norambuena & Piper 2000). Reducing propagule accumulation may also limit the equilibrium density of weeds at newly-invaded sites. There are many examples from the biocontrol literature where seed feeders alone or in combination with bud and flower feeders have achieved this end, including acacias (Dennill & Donnelly 1991; Impson & Moran 2004; Moseley et al. 2009) and

Hakea (Le Maitre et al. 2008). Reducing seed-set to low levels might also reduce the weed's ability to reinvade following herbicide treatment, complementing existing control strategies.

'No evidence that BCAs can disperse over these distances…find such targets…efficiency..locating these targets would need to be high.'
Once established, long-distance dispersal will be enhanced by regional council staff and land managers. Similar biocontrol agents have dispersed effectively e.g. gorse seed weevil dispersed 10 km in 6 years. See supplementary information presented by (Paynter & Bellgard 2011). In our experience there is no reason to think host-finding will limit dispersal rate or effectiveness.

'Introduction of alien weevils is intrinsically hazardous to ..(NZ weevil fauna)…Application states …no knowledge of (ecological factors) relevant to indigenous weevil populations….might have an impact on this taonga….Introduction of M. aethiopoides remains one of the most egregious errors.'
This issue is discussed adequately in the application. Any interactions between control agents and native weevils will only be evident in the presence of a barberry host. Any disruption to native weevil ecology through apparent competition will be minimal compared with the ecosystem changes imposed by barberry infestation. In fact, the framework developed by Paynter et al. (2010) predicts that these agents are unlikely to be attacked by parasitoids in NZ.

M. aethiopoides has been reported attacking other weevils, including natives and a biological control agent, but at levels that vary greatly from time to time and from place to place. There is no direct field evidence that it has adversely affected populations of any non-target weevil in New Zealand.

'The strategy of introducing multiple biological control agents is fundamentally flawed.'
On the contrary, history shows that the introduction of multiple agents increases the rate of success in weed biocontrol. Selecting a single 'winner' is a less successful strategy.

'Anthonomus will interfere...establishment of Berberidicola by reducing fruit availability… not in application'.
Interference between agents will not affect initial establishment as releases will be made at different sites. When they occur together the degree of interaction will vary. Some years and some places will favour one agent over the other. There are few examples in the scientific literature where the impact of two agents together was less than that of either agent alone. There are good examples where agents that attack flowers/flower buds have been introduced in tandem with seed feeders include *Sesbania* (Hoffmann & Moran 1998); *Hakea* (Le Maitre et al. 2008); *Acacia longifolia* (Impson et al 2004).

'Not part of an overarching strategy…'
Darwin's barberry features in the Regional Pest Management Strategies of most regional councils. It is their collective judgement that without intervention, Darwin's barberry will become widespread and abundant, and effective control by conventional means will soon be lost. For the most part, biocontrol is usually attempted when all other attempts to control a weed have either failed, or become prohibitively expensive. In this case, early action aims to prevent the accumulation of the weed (and its adverse econmic and environmental), and retaining the effectiveness of conventional techniques.

'Little consideration given to alternatives…Targeting vectors…blackbirds.'
This is an intriguing suggestion. However, annual control by poisoning, even if conducted only in the immediate vicinity of barberry infestations, would be ruinously expensive, technically difficult, and would risk non-target impacts on native birds that feed on barberry fruits such as silvereye and kereru.

Submission 102582 Greater Wellington Regional Council
No additional comment

Submission 102583 Federated Farmers of NZ (Inc)
No additional comment

Submission 102584 Te Rūnanga o Ngāi Tahu
No additional comment
Ngāi Tahu requests that Te Rūnanga and Papatipu Rūnanga be informed of releases, and that information on effectiveness be made available. Environment Southland is in close contact with the local Papatipu Rūnanga, and will liaise over releases.

Submission 102585 Otago Regional Council
No additional comment

Submission 102586 Wellington Botanical Society
..propose gradual release from containment..(if) no indications of any adverse effects …releases in new locations…
Both agents can disperse freely. By the time any adverse effects were detected, it would already be too late to mount successful eradication. While isolation on an offshore island could delay colonization we must assume that release on any New Zealand island would eventually lead to establishment on the mainland.

References

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