# Monitoring the effect of the Madeira vine beetle (*Plectonycha correntina*) on its host plant Madeira vine (*Anredera cordifolia*)

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## Background

Madeira vine (*Anredera cordifolia*) has become a serious environmental weed in Australia due to its extreme growth rates of up to 6 m stem length during the growing season and prolific aerial bulbils and tuber production (Cagnotti *et al*. 2007). As a result, biological control of this highly invasive vine has been undertaken in Queensland and NSW.

## Current situation

The South American Madeira vine beetle (*Plectonycha correntina*) has been mass reared and released into Madeira vine infestations in south-eastern Queensland from May 2011 onward where field observations suggest that the beetle successfully overwintered at 51 % of sites. Further post-winter releases in south-eastern Queensland, northern NSW, Central Queensland and Far North Queensland are also showing positive results with 42 % of sites reporting both adult and reproductive stages of the beetle present (Biosecurity Queensland reports).

Sourced from Biosecurity Queensland, the Madeira vine beetle has been established in the glasshouses at the biological control facilities at the Grafton Primary Industries Institute. From June 2011 to June 2012, 8770 beetles have been released over 87 sites in NSW (Minutes of the NSW Environmental and Aquatic Weeds Biological Control Taskforce 21st June 2012 – Port Macquarie).

## Biology of *Plectonycha correntina*

The Madeira vine beetle adult is approximately 5.2 mm long and 2.1 mm wide. It is black with a reddish brown pronotum and elytra which may also have black spots. The adults are found on the underside of leaves from which they easily drop off when disturbed (Cagnotti *et al.* 2007). Eggs are laid in groups of eight to fifteen on the underside of leaves. They are cylindrical and yellowish and approximately 0.3 mm wide and are deposited in a fish bone pattern. The larvae are also found on the underside of leaves. The adult beetle removes parts of the mesophyll of the leaf which leaves scars similar to 'windows' on the leaves

while mature larvae remove whole sections of the leaves (Snow *et al.* 2012) causing margin damage as well as rounded holes all over the leaves (Cagnotti *et al*. 2007). The larvae are covered by a glutinous substance partly composed of powdery material and exuviae (Cagnotti *et al*. 2007). The larvae cast off their brown glutinous substance and pupate in the soil, emerging after approximately 20 days as adults (Cagnotti *et al.* 2007).

**Objectives**

The objective of the monitoring trial was to undertake a survey on some of the beetle release sites, and to trial a monitoring technique that can be easily used by all land managers, environmental officers and volunteers to monitor the success of the introduction of the bio-control agent. The survey was designed to indicate presence and spread of the various developmental stages of the bio-control agent as well as the degree of damage to the host plant.

**Methods**

We surveyed 12 release sites and 6 control or non-release sites, in order to establish general herbivory levels on Madeira vine. Sites were visited between 26 November 2012 and 6 February 2013. The release sites were situated between Knorrit Flat (approximately 35 km northwest of Taree) and Bomaderry near Nowra. Recording sheets and instructions for repeating our methods are attached.

At the beetle release sites, we established a 5 m radial plot with two measuring tapes positioned at right angles at the centre of the release site. Two people conducted a 10 minute search (equivalent to one person doing a 20 minute search) in the 5 m radial plot and recorded the presence of any Madeira vine beetle, larvae, glutinous substance, and egg as well as feeding damage on leaves (holes and edge damage). We then recorded level of damage to the host plant by haphazardly placing twenty 25 x 25 cm quadrats where Madeira vine occurred in the plot and assessing the number of leaves in the quadrat, the number damaged, and if damaged, the proportion of leaf damaged. Following this we assessed agent spread by walking in each cardinal direction and recording distance to release spot of any damage observed. If the site was suitable, photopoints were established.

We were unable to distinguish between damage from the vine beetle and damage caused by other species. Leaf damage was scored using the following categories: 0-5%, 5-10%, 10-25%, 25-50%, 50-75%. We derived two damage scores: (1) the average percentage of leaves damaged across all quadrats sampled; and (2) the average leaf damage (% eaten) across all quadrats. For damage score (2) we used the midpoint of each damage category as an estimate of leaf damage, e.g. 0-5% become 2.5%, and multiplied the average damage score by the proportion of leaves in the quadrat that were damaged to create an overall level of damage for the quadrat. These percentages were then averaged across sites where beetles were absent, present, and at control sites.

We conducted general linear models on the proportion of leaves damaged, average leaf damage scores for damaged leaves and the quadrat damage score to compare differences among control sites and release sites where the beetle was present.

**Results**

Three sites had adult beetles present at release sites and at a further site (Harrington) adult beetles were present away from the release site (Table 1). There were other signs of beetle presence at a further five release sites (larvae, a glutinous substance and/or eggs). At the remaining three sites, larvae and/or glutinous substance were found only away from the release site. Further from the release site, evidence of beetle presence was found at eight of the twelve sites overall.

There was no difference between release sites and control sites in the proportion of leaves that were damaged by herbivory ($F_{1,17}$ = 0.297 , p = 0.593) or the leaf damage level ($F_{1,17}$ = 1.16 , p = 0.296). Furthermore, quadrats did not differ in the overall damage scores ($F_{1,17}$ = 0.959 , p = 0.341) suggesting that there is currently little impact of the beetle on Madeira vine. As this may be a result of lack of establishment or lack of beetle effectiveness, we analysed the data further.

When we compared the proportion of leaves damaged at sites where adult beetles were observed (rather than just released, n = 4) to release sites where the beetle could not be found (n = 8), there was a significant difference. Sites where beetles were found had a higher percentage of damaged leaves than sites where the beetle was not found ($F_{1,10}$ = 13.01 *p*= 0.005, Figure 1) and greater damage on attacked leaves ($F_{1,10}$ = 6.15 *p*= 0.033).

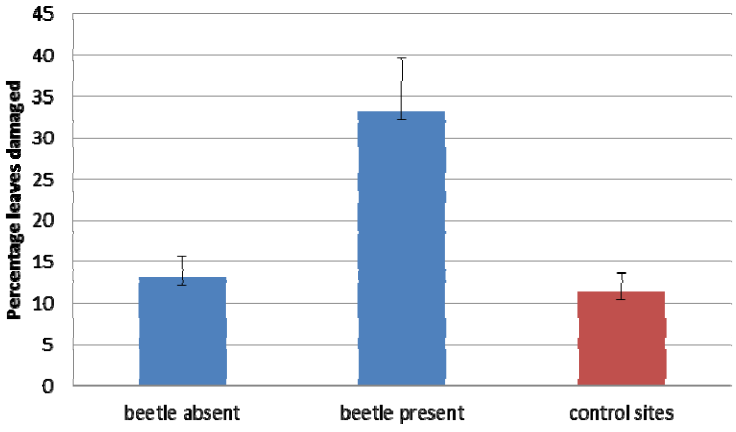


**Figure 1:** Percentage of leaves damaged at release sites where adult beetle was encountered at survey (beetle present), where beetle was not encountered at survey (beetle absent), and control sites (no beetle released)

Furthermore, overall damage levels in quadrats were also greater where the beetle was present compared to sites where the beetle was absent ($F_{1,10}$ = 13.720, *p*= 0.004, Figure 2).

Despite the difference, leaf damage scores per quadrat were extremely low indicating that at the moment the beetle is not having an ecologically significant impact on the growth of Madeira vine.

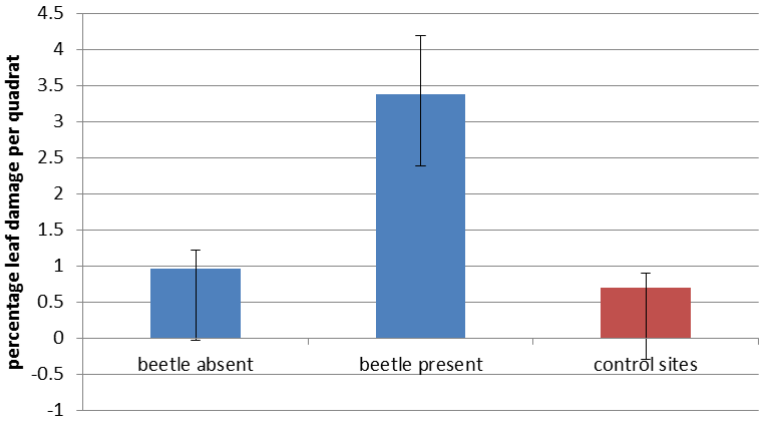


**Figure 2:** Average leaf damage (% leaf eaten) per quadrat at release sites where beetle was encountered (beetle present), where beetle was not encountered (beetle absent), and at control sites (no beetle released)

**Table 1: Madeira vine beetle evidence and spread. Evidence of beetle establishment was listed as A=Adult beetle, G=Glutinous substance, L=Larvae, and E=Eggs**

| Site | Agent release date | Agent presence at release spot | Agent dispersal from release spot | Notes on agent | Notes on Madeira vine |
|---|---|---|---|---|---|
| 1 Lakeside Windeyers Creek | 10/05/2012 | - | 6 m; L, G | Larvae and glutinous substance found 6m from the release spot | Infestation size: 30m², site is bordering wetland, Drainage Reserve, close to back gardens and houses and cycle track |
| 2 Knorrit flat | 1/12/2011 | A, G | 9.4 m; A | Adult beetle at release spot and further away | Infestation size: about 100 m length along remnant rainforest edge, moist shaded site with afternoon sun, bordering campsite |
| 3 Harrington | 1/12/2011 | - | 53.4 m; A, G, E | Adult beetle, glutinous substance, clutch of eggs found 50 m away from release spot | Infestation size: 100 m², wetland/littoral RF edge, bordering BIG4 campground |
| 4 Dyers Crossing | 12/05/2012 | G | - | Access problem on sheer slope | Infestation size: ?, riparian rainforest edge bordered by farm and fields, very steep and inaccessible lower down to the river |
| 5 Bandon Grove | 11/03/2012 | L, G | 35.2 m; L ,G | Larvae and glutinous substance at release spot and further away | Infestation size: 100 m², close to river (10 m) rest area next to road |
| 6 Daisley Crescent, Charlestown | 5/04/2012 | G | 8 m; G | Glutinous substance at release spot and further away | Infestation size: 100 m², bushland with drainage retention basin nearby, release 2 metres from road |
| 7 Little Beach, Swansea Heads | 5/04/2012 | - | 5.5 m; G | Glutinous substance detected outside release spot | Infestation size: 5000 m², 100 m from ocean, north-facing slope, degraded coastal bush reserve, (Lantana/bitou) and dry. Release site buried under fallen coral tree, continuous infestation. |

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|---|---|---|---|---|---|
| 8 Palm Grove NR | 1/11/2012 | A, G, E | 13.1 m; L, G | Adult beetle, glutinous substance, eggs at release spot. Larvae and glutinous substance 13.1m away | Infestation size: 100 m², infestation isolated in open paddock bordered by relative moist lush rainforest edge, 150 m from river |
| 9 Busaco Rd, Marsfield | ?/04/2012 | L ,G | - | Larvae and glutinous substance at release spot | Infestation size: ? , end of Cul-de-Sac, degraded dry open bushland (Lantana) bordering houses and back gardens, patchy infestation, dense around release site |
| 10 Punt Rd, Gladesville PR RP | 19/01/2012 and 05/04/12 | - | 37.7 m; G | Glutinous substance over 37 m away | Infestation size: 100 m²?, disturbed open forest (Tradescentia, Lantana etc) bush regeneration evident, continuous infestation |
| 11 Manildra lunch room, Bomaderry | 21/03/2012 | A | - | Adult beetle at release spot | Infestation size: 25 m², M. vine growing over trees and shrubs surrounded by factory buildings and yards. Dry climate, continuous infestation |
| 12 Jackson Place, Wolli Creek RP | Unknown | G | - | Glutinous substance at release spot | Infestation size: 400 $m^2$, release site next to walking track, shady open shrub layer 95 % weeds, adjacent to gully |

**Left side: Knorrit Flat site, (Photo: Terry Hemmingway), right side: Daisley Crescent site**

**Dyers Crossing**

**Palm Grove**

## Discussion

Overall we identified leaf damage on Madeira vine which appeared to be associated with the Madeira vine beetle as well as some evidence of attack that may be from other organisms. In neither case were levels of damage great, with usually less than 4% of the foliage in a quadrat being attacked. As a biological control agent, the beetle is currently having relatively little impact, albeit at most sites beetles were only recently released. Where the beetles had established and were present at the time of our survey, they had caused damage to a higher number of leaves and leaves that were attacked showed greater damage, than where adult beetles were not sighted.

Our results suggest that populations of the beetle did not establish at a number of release sites. Although all release sites were disturbed, some sites appeared to be more suitable for release of the beetle. For example, the lowest percentage damage of 5.58% was observed at Little Beach, Swansea Heads where the tree under which the beetle had been released had fallen over and where there was a generally drier and harsher climate very close to the ocean. Whereas Knorrit Flat, the site with the highest percentage damage, had lush vegetation and a dense cover of foliage, and anecdotal observation of drastic declines in Madeira vine foliage cover prior. Furthermore, several sites experienced minor drought and the authors noted that Madeira vine vigour was reduced (leaves smaller and fewer) and that this coincided with poor evidence of beetle presence. This may suggest that persistence of the beetle is enhanced by moist, dense and less disturbed vegetation which might yield a higher variety of microhabitats, but further work will be required to confirm this. The data obtained for the agent spread also seems to suggest that the actual release spots where the beetles had been placed did not always seem to coincide with where the beetle was found. At Lakeside Windeyers Creek, Harrington, Little Beach and Punt Road (Gladesville) larvae, eggs or the black glutinous substance was found some distance away from the release spot. There is clear evidence that the beetle has the capacity to spread from release sites, perhaps to more suitable microhabitats.

## Recommendations

The following investigations and further trials would be useful to determine the factors responsible for poor establishment of the control agent at some sites and to evaluate the effectiveness of the beetle at established sites.

1. Undertake a set of releases that are at sites of different vegetation cover to investigate the influence of vegetation cover on establishment rate. It would also be useful to investigate releases at different densities of Madeira vine. Monitoring the spread of the beetle should be incorporated into these studies.
2. Undertake a controlled set of releases at different times of year to investigate the best time for release.
3. Field trials for predation on the control agent by other insects (as many spiders and ants were observed on damaged leaves).

Before more Madeira vine beetles are released, the prospective sites should be first monitored and the general level of leaf damage should be recorded. Where suitable, photo points should be established before release of control agents, i.e. dense patch of Madeira vine infestations clearly visible. Successionally hot and dry weather should be avoided when releasing the beetle. Sites should be selected as release sites only if they have a dense infestation of Madeira vine until further work establishes the threshold density of Madeira vine to enhance establishment.

## Acknowledgements

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