The release of *Plectonycha correntina*, a leaf feeding beetle for the biological control of Madeira vine

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Summary Madeira vine, *Anredera cordifolia* (Ten.) Steenis (Basellaceae) is a South American perennial vine that forms dense mats over trees and shrubs. It is a major environmental weed of coastal and sub-coastal areas in Queensland and New South Wales and it poses a significant threat to biodiversity in riparian, sclerophyll and rainforest communities. The South American leaf-feeding beetle *Plectonycha correntina* Lacordaire was approved for release as a biological control agent in February 2011. The beetle was subsequently mass reared and introduced into madeira vine infestations in south-eastern Queensland from May 2011 onward. Both adults and larvae of this insect are leaf feeders, with larvae being particularly damaging. Post release field monitoring determined whether the beetle had established, the rate of spread from the initial release site and level of damage. Field observations at 29 sites where releases had been made before winter (6100 beetles in total) were made in October 2011. The insect had successfully overwintered at 51% of these sites, with adults, larvae and eggs being recorded. Post-winter releases of another 20 462 beetles over 72 sites in south-eastern Queensland, five in northern NSW, one in Central Queensland and two in Far North Queensland are also indicating promising results with insects being present and reproducing at 42% of sites in the following autumn. Damage levels at all sites were generally low, reflecting that this was the first year of releases, but 20% loss of leaf area was estimated at two sites. Preliminary analysis of data indicated that establishment does not appear to be closely related to the number of insects released, so other factors such as season of release, light levels or density of predators may be important.

Keywords Madeira vine, *Anredera cordifolia,* leaf beetle*, Plectonycha correntina,* biological control.

INTRODUCTION

Madeira vine, *Anredera cordifolia* (Ten.) Steenis (Basellaceae) is a South American perennial vine that forms dense mats over trees and shrubs. It is a major environmental weed of coastal and sub-coastal areas in Queensland and New South Wales (Vivian-Smith *et al.* 2007) and a significant threat to biodiversity in riparian, sclerophyll and rainforest communities (Floyd 1989). It has recently been declared a Weed of National Significance.

Following biology and host range studies in Argentina (Cagnotti *et al.* 2007) and Australia (Biosecurity Australia 2010), the South American leaf-feeding beetle *Plectonycha correntina* Lacordaire (Coleoptera: Chrysomelidae) was approved for release as a biological control agent in February 2011 (Palmer 2012). The beetle was subsequently mass reared and introduced into madeira vine infestations in Queensland and New South Wales from May 2011 onward.

Both adults and larvae of this insect are leaf feeders, with larvae being particularly damaging. The insect is multivoltine and has a life span ranging from 20 to 130 days with the female laying egg batches of 1–35 eggs for a mean (±SEM) of 771 ± 155 eggs per lifetime (unpub. data). Eggs hatch in 5–6 days. The larvae take 9–16 days to complete development. Larvae feed gregariously as early instars and accumulate a slimy layer of faecal material which is presumed to protect against predation. Larvae leave the plant to pupate on the ground and pupation takes 19–21 days (Cagnotti *et al.* 2007). Damage is unique in appearance. Adult feeding removes portions of mesophyll, leaving a 'window' like scar on the leaf. Mature larvae remove whole sections of leaf tissue and often leave the black sticky coating with their exuvae (Figure 1).

This paper describes the mass rearing and release of the beetle in Australia. Preliminary post release field monitoring was conducted to assess progress towards establishment, the levels of damage and the spread from the initial release sites. The importance of the number of insects used for releases relative to establishment is discussed.

MATERIALS AND METHODS

Plectonycha correntina was reared in air-conditioned glasshouses (22–27°C and 70% RH) at the Ecosciences Precinct, Dutton Park, Brisbane, Australia. The insects were reared on potted madeira vine plants in cages (1m × 1m × 60cm) with potting mix as a pupation medium. Adults were sometimes stored in holding cages while awaiting release and always had the opportunity to mate in cages before their release. The insect proved relatively easy to rear and recoveries from 50 adults placed on 6 potted plants were approximately 500 adults in the next generation. Under this regime generations were produced every 6 weeks approximately.

Insects were released into the field in varying numbers (but usually between 100 and 1000 adults), depending on availability. Almost all these releases were made into typical, relatively discrete infestations of madeira vine (which is not found in lengthy contiguous populations). Releases began in May 2011. A single release was made at all sites; usually at one release point. All the releases made before the winter of 2011 were made in south-eastern Queensland, mostly in the western suburbs of Brisbane (Figure 2). After winter, releases were also made in other parts of Queensland and in New South Wales through a mass rearing program at the Grafton Primary Industries Institute. By May 2012 some 33 500 adults had been released in Australia.

A GPS location was recorded for each site and photographs taken for future comparisons. Initial field observations of sites where releases had been made before and during winter (6100 beetles in total) were made in October 2011. Further monitoring was conducted toward the end of summer and early autumn. At each site a ten minute search was undertaken in a 5 m radius around each release point. The numbers of each life stage present were recorded. A visual estimate of the percentage of damage to foliage within this radius was also recorded to the nearest 10%. Insect populations were then followed to their extremities and the distance of spread from the single discrete release point was calculated using GPS. Additional regular observations of phenology were made at several of the sites during the study.

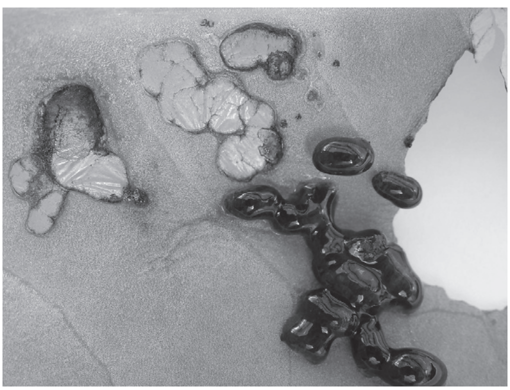

Figure 1. Typical leaf damage of 'windows' (adults) and complete tissue removal (larvae) and several later instars covered in their protective coating.

Sites were grouped for comparison by timing of release as 'autumn-winter' or 'post-winter'. Establishment was assessed only for the autumn-winter releases and was deemed to have occurred where the insect was recovered in spring 2011 and persisted over the summer. An assessment of the effect of release batch size (Table 2) on insect recovery in autumn 2012 was made within each release-timing group.

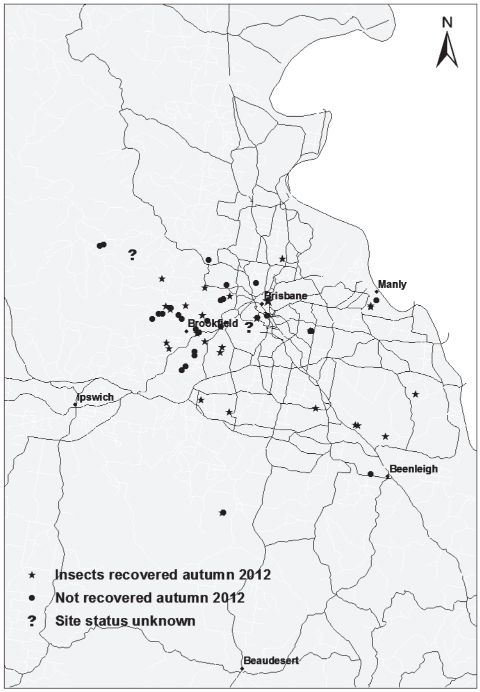

Figure 2. Release sites in the Brisbane area.

Table 1. Summary of observations at sites across south-eastern Queensland. Data are split into autumn-winter releases and post-winter releases.

Site groups	No. of sites	% of group totals
Autumn-winter releases		
Overwintered – persistent	12	41
Overwintered – not persistent	3	10
Failed to overwinter	14	48
Total	29	
Post-winter releases		
Present in autumn	18	42
No insects evident	25	58
Total	43	
Total sites both categories	72	

winter release sites in spring 2011 and autumn 2012 respectively (Table 1). The adult beetle appeared to 'overwinter' from around May to August (in south-eastern Queensland), slowing feeding and reproduction during these months; a trait also noted in colonies that were reared in shade houses during winter. The insect was recovered in autumn 2012 from 42% of post-winter release sites and 42% of all release sites.

Release batch size did not appear to affect insect recovery rates (Table 2), suggesting that rate of establishment would not be improved by large release size.

Most severe foliage damage occurred very close to the actual release point at most sites though occasionally was more widespread. Estimates of damage to leaves at sites where the insect was present ranged from 0 to 20% (n = 8).

The maximum distance that insects moved away from initial release points ranged from 4 to 35 m (Table 3).

Table 2. Number and percentage of release sites from which *Plectonycha correntina* was recovered from madeira vine in Queensland in autumn 2012 following releases in autumn-winter 2011 categorised by release batch size.

Batch size (no. insects)	No. of release sites	No. of establishments	% of sites established
40-200	36	8	22
201-400	17	1	6
401-600	7	0	0
601-800	8	2	25
801-1000	4	1	25

Table 3. Maximum distance (m) of dispersal of *Plectonycha correntina* from release point.

Site	Max. Distance
Nundah	35
AFRS	20
Redlands	8
Kenmore	6
Shailer Park	4

DISCUSSION

While there was a high level of damage clearly visible at a few sites, most showed no obvious insect presence by autumn 2012. Since many sites are very difficult to access, results may be biased towards accessible or visible areas. Additionally, the size of weed infestation, difficulty of access into the infestation, the proportion of foliage in tree canopies and density of foliage at some sites limited detection so that the proportion of successful releases is probably underestimated. This view is reinforced by the observation that the sites which have been observed to have high levels of damage are open, easily accessible sites. Over the longer term, if insect populations increase, damage will become easier to identify on a larger scale.

Preliminary data suggest that the rates of establishment do not appear to be influenced by the size of release batch. Factors such as the timing of insect releases may be more important. Ecological factors such as the presence of predatory birds (e.g. small, highly mobile insectivores) and insects may also have a role in regulating beetle populations. Light levels, soil moisture and nutrient levels (Osunkoya *et al.* 2010a, Osunkoya *et al.* 2010b) may also influence quality of madeira vine at individual sites and hence the developmental success of the larvae.

It is difficult to comment on the rate of spread of these insects at this early stage. Only two sites showed any appreciable movement away from the original release site. One of these sites was disturbed by council spraying which may have driven the beetles across to another area approximately 35 m away. Once again, the limitation of measuring spread is very evident with many sites being partially or totally inaccessible. This insect is mobile and it was anticipated that it could readily spread into new areas. However there is little evidence so far to suggest that it will spread quickly over large areas. Paynter and Bellgard (2011) found positive correlations between insect dispersal rates and both type of dispersal and insect voltinism. These factors together with the insect becoming a glasshouse pest at both the Ecosciences Precinct and the Grafton Primary Industries Institute indicate it has the potential to disperse effectively in an open situation, although there is a notable absence of predators such as birds in these environments. If the insect proves to be a slow disperser, but damaging to madeira vine, redistribution after initial releases may be required to assist spread. Agents such as *Dactylopius opuntiae* (Cockerell), *Apthona* spp. and *Cyphocleonus achates* Fahraeus are very slow dispersers but became highly successful at suppressing their target weed (Paynter and Bellgard 2011).

The release of 7500 insects across 51 sites in New South Wales began in September 2011 and the insect is known to have persisted at a few sites, however it is too early to comment on establishment. Similar comment could be made about the releases in northern Queensland at Atherton and Mackay.

While this release program is still in the early stages, almost half the release sites have persistent insect presence and this augurs well for more widespread establishment over the longer term. Widespread establishment of biological control insects can take up to 10 years in some cases (Mo *et al*. 2000).

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REFERENCES

Biosecurity Australia. (2010). 'Final risk analysis report for the release of *Plectonycha correntina* for the biological control of *Anredera cordifolia* (Madeira vine)'. Biosecurity Australia Canberra.

Cagnotti, C., Mc Kay, F. and Gandolfo, D. (2007). Biology and host specificity of *Plectonycha correntina* Lacordaire (Chrysomelidae), a candidate for the biological control of *Anredera cordifolia* (Tenore) Steenis (Basellaceae). *African Entomology* 15, 300-9.

Floyd, A. G. (1989). The vine weeds of coastal rainforest. *In* Proceedings of the 5th biennial noxious plant conference, ed P. Gorham, pp. 109-15. (NSW Agriculture & Fisheries, Sydney, NSW).

Mo, J., Treviño, M. and Palmer, W. A. (2000). Establishment and distribution of the rubber vine moth, *Euclasta whalleyi* Popescu-Gorj & Constantinescu (Lepidoptera: Pyralidae) following its release in Australia. *Australian Journal of Entomology* 39, 344-50.

Osunkoya, O. O., Bayliss, D., Panetta, F. D. and Vivian-Smith, G. (2010a). Leaf trait co-ordination in relation to construction cost, carbon gain and resource-use efficiency in exotic invasive and native woody vine species. *Annals of Botany* 106, 371-80.

Osunkoya, O. O., Bayliss, D., Panetta, F. D. and Vivian-Smith, G. (2010b). Variation in ecophysiology and carbon economy of invasive and native woody vines of riparian zones in south-eastern Queensland. *Austral Ecology* 35, 636-49.

Palmer, W. A. (2012). *Anredera cordifolia* (Ten.) Steenis – Madeira vine. *In* Biological Control of Weeds in Australia, eds M. Julien, R. McFadyen and J. M. Cullen, pp. 60-4. (CSIRO Publishing, Melbourne).

Paynter, Q. and Bellgard, S. (2011). Understanding dispersal rates of invading weed biocontrol agents. *Journal of Applied Ecology* 48, 407-14.

Vivian-Smith, G., Lawson, B. E., Turnbull, I. and Downey, P. O. (2007). The biology of Australian weeds. 46. *Anredera cordifolia* (Ten.) Steenis. *Plant Protection Quarterly* 22, 2-10.