The jewel beetle (*Hylaeogena jureceki*): a new biological control for cat's claw creeper (*Dolichandra unguis-cati*) in Queensland

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Summary Cat's claw creeper (*Dolichandra unguis-cati* (L.) L.G.Lohman) (Bignoniaceae) is a serious environmental weed in Queensland and New South Wales. It presents a threat to riparian and rainforest ecosystems and is often found in inaccessible locations that are not suitable for chemical or physical control methods. This makes biological control an important tool for managing this weed. The jewel beetle *Hylaeogena jureceki* Obenberger was approved for release in Australia in May 2012. Since approval, approximately 35,000 insects have been released at 53 sites. Multiple and single releases have been made at sites with the number of insects released ranging from 20 to 1590. Post-release monitoring before and after winter found the beetle persisting at 73% of release sites in southeast Queensland. Within the release sites, the beetle appears to disperse widely, up to 100 m over a 15 month period. Based on these early field results, it appears that the beetle will establish and spread in Queensland and New South Wales. In addition to direct field releases, the beetle has been supplied to various community and Landcare groups for breeding and field release. This will hasten the spread of the insect to a wider area. It is expected that the jewel beetle will complement the leaf-sucking tingid (*Carvalhotingis visenda*) and leaf-tying moth (*Hypocosmia pyrochroma*) that were released in 2007.

Keywords Cat's claw creeper, *Dolichandra unguis-cati*, *Carvahotingis visenda*, *Hypocosmia pyrochroma*, *Hylaeogena jureceki*.

INTRODUCTION

Cat's claw creeper (*Dolichandra unguis-cati* (L.) L.G.Lohman) (syn. *Macfadyena unguis-cati* (L.) A.H.Gentry); (Bignoniaceae) is a serious environmental weed in Queensland and New South Wales. It presents a threat to riparian and rainforest ecosystems (Vivian-Smith and Panetta 2004) and is often found in inaccessible or ecologically sensitive locations that are not suitable for chemical or physical control methods. Mechanical control provides a temporary solution, however regeneration from underground tubers continues for many years (Dhileepan *et al.* 2010). This makes biological control an important tool for ongoing management of cat's claw creeper. In 2009 the jewel beetle *Hylaeogena jureceki* Obenberger (Coleoptera: Buprestidae) was imported into the quarantine facility at the Alan Fletcher Research Station Sherwood, Queensland from the Agricultural Research Council-Plant Protection Research Institute Pretoria, South Africa. This insect is native to tropical South America (Argentina, Paraguay and Brazil). It has a short generation time, long-lived adults and a high reproductive rate, which potentially make it a good biocontrol agent (Williams 2003). Choice and no-choice trials in quarantine using 38 plant species from 11 families demonstrated that the jewel beetle was highly host specific (Dhileepan *et al.* 2013). The jewel beetle was subsequently approved for release in Australia in May 2012. Another biocontrol agent of cat's claw creeper, the leaf-sucking tingid (*Carvalhotingis visenda* (Drake & Hambleton)), has become widespread and damaging in some areas since its release in 2007. A leaf-tying moth (*Hypocosmia pyrochroma* Jones), was also released to control cat's claw creeper in 2007, however continued monitoring has not shown any signs of widespread establishment.

This paper gives an overview of the mass rearing, release, persistence and spread of the jewel beetle. The likelihood of establishment will be discussed based on these activities.

MATERIALS AND METHODS

Insect Following approval to release, jewel beetle colonies were transferred out of quarantine to outdoor glasshouses for mass rearing. Both the adult (Figures 1 and 3) and larvae of the jewel beetle are leaf feeders, with the larvae being leaf miners (Figure 2). The adult jewel beetles are long lived (up to 314 days). Females lay eggs on the underside of leaves, predominantly around outer margins of the basal leaves. Eggs take 12–17 days to hatch. Larvae mine the leaf and remain within the mine until pupation, approximately 14–24 days later (Williams 2003, Dhileepan *et al*. 2013). The larvae pupate in a distinctive disc-like pupal case for 11–24 days (Figure 2). The pupal case can remain in the leaf, or drop to the ground (leaving a round hole in the leaf). The duration for development from egg

to adult ranges from 52 to 63 days (Dhileepan *et al.* 2013).

Rearing method The jewel beetles were reared in climate-controlled glasshouses at the Ecosciences Precinct at Boggo Road in Brisbane, Queensland. Glasshouse temperatures were set at 22–27°C (day/night respectively) with a relative humidity of 60%. The jewel beetles were reared on both long-pod and short-pod varieties (Shortus and Dhileepan 2010) of cat's claw creeper (mixed within each cage). Plants were field collected as seedlings and potted into 140 mm pots. Insect-proof rearing cages (100 cm × 100 cm × 60 cm) covered in fine voile mesh (45 gsm) were used for mass-rearing the jewel beetle. Eighty jewel beetle adults (of unknown sex) were introduced into each rearing cage with 30 potted cat's claw creeper plants. After two to three weeks of oviposition, all adult beetles were removed and re-used in new culture cages or released. Plants were watered sparingly once leaf-mining had begun to reduce fungal growth in cages. Adult progeny were collected from the culture cages after seven to eight weeks.

Field release Release sites were selected based on several criteria. Sites with easy access, areas not subjected to periodic flooding, and those that were not subjected to physical or mechanical management options were selected preferentially. Releases were made directly by the Biosecurity Queensland research staff in strategically identified release sites in southeast Queensland. Releases were also made through local councils, Landcare groups or property owners for distant release sites (e.g. Mackay, Atherton, etc.). In each release site, jewel beetles were released in batches ranging from 20 to 1590 insects. Batch sizes were determined by the availability of insects in the colony. Releases began in August 2012 and have continued through all seasons.

Jewel beetles were collected from colony cages with an aspirator connected to a small vacuum cleaner. These insects were either used in new colony cages or field released. Prior to release, small batches of insects (50–100) were packed into (170 mm × 70 mm × 110 mm) plastic boxes with cat's claw creeper cuttings. There was a mesh layer placed beneath the plastic lid which had a large hole for ventilation. Release of jewel beetles involved draping cuttings of cat's claw creeper infested with jewel beetle adults onto vines at infestation sites and gently tapping remaining insects onto the vines. A GPS reading was taken for each release point. A variety of release strategies and areas were used: multiple and single release sites, riparian and non-riparian areas, and coastal and inland areas.

To assist with the widespread release of *H. jureceki*, the insect was mailed to community groups and landholders. Insects to be posted were packed in the same boxes as described above, which were packed within a cardboard postage box and sent to arrive the next business day by express post (where

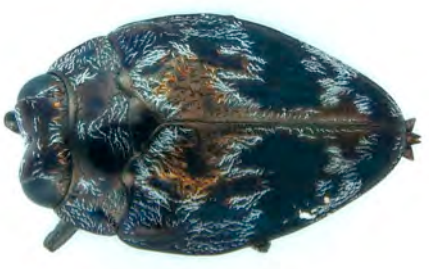

Figure 1. Adult of *Hylaeogena jureceki* (magnified ×23).

Figure 2. Larval mines and circular pupal cases of *Hylaeogena jureceki.*

Figure 3. *Hylaeogena jureceki* adults and leaf feeding damage.

available to an area) or to a post office box if available. Insects needed to be kept relatively cool during transit, so delivery to post office boxes or to be held for collection at a post office was preferred. Insects can survive in boxes for up to three days, however foliage dries out quickly and needs to be replaced regularly. Insects were always posted at the beginning of the week to reduce the risk of being held up in the mail, particularly if overnight delivery was not available to more remote areas.

Survey method Release sites were assessed periodically for the presence or absence of the insects and their various life stages to give an indication of likely establishment. In particular, sites have been inspected before and after winter in order to elucidate overwintering behaviour and success. Sites were surveyed for ten minutes and the number of adults and live larval mines were recorded. Live larval mines could be detected by the yellowish larvae within the leaf. An estimation of the spread of the insect was also recorded after surveying outward from the initial release point. Vertical distances travelled were also estimated where possible with binoculars. Observations of insect behaviour, such as aggregation, were also noted.

RESULTS

After 52–63 days, each cage yielded upward of 500 new adults. In total, 35,000 jewel beetles have been released at 53 sites (Figure 4), with release numbers peaking in the warmer months. This figure does not include releases made by other groups, however those releases would be minimal at this stage.

Jewel beetles were present at 73% of release sites surveyed in late summer and autumn of 2014 and appeared to be actively reproducing at all of these sites. Regular observations at three local sites (Oxley, Carindale and Fig Tree Pocket) have shown a sharp increase in the number of adult jewel beetles present and concomitant adult damage during early autumn 2014. Not all sites could be surveyed due to either the short time since release or the time to travel to more distant sites.

At sites where the jewel beetles were released in winter, insects were found in the subsequent spring and summer, indicating a capacity to overwinter, albeit with no apparent reproduction and little damage to cat's claw creeper during the cooler months.

The furthest estimated spread was approximately 100 m from an initial release point (Fig Tree Pocket site) over 15 months. Where adults were observed in the field, they were often found aggregated on the same tree trunk (this occurred on multiple trees at multiple sites). Insects were observed to be aggregating on foliage in the sun. Foliage damage from adults was widespread at sites and estimated to be as far as 6 m vertically. These sites were established >12 months previously.

DISCUSSION

Under glasshouse conditions, the jewel beetle underwent five to six generations a year. However, it is likely that the jewel beetle will undergo three to four generations from spring to autumn, under field conditions in southeast Queensland, with the adults overwintering either in an inactive or less active state.

Preliminary results indicate that the jewel beetle is highly mobile and is likely to establish at most sites where it has been released. Jewel beetle dispersal of 100 m now surpasses the 60 m previously recorded

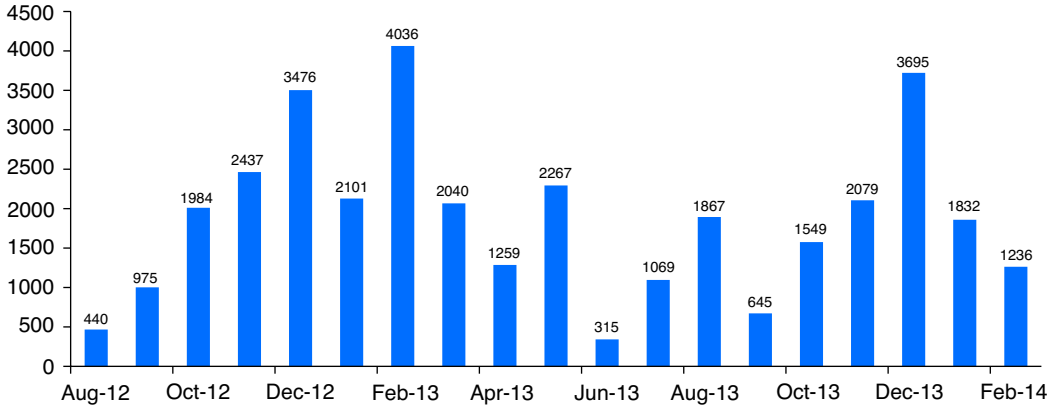

Figure 4. Number of releases for adult jewel beetles for each month of the mass release program.

over an eight month period (Snow and Dhileepan 2013). The insect has shown a capacity to overwinter, although more detailed studies of temperature tolerances are required to elucidate whether overwintering occurs in the adult, larval or pupal phase of development. Sites will be very closely monitored over winter to determine how overwintering is achieved by this insect. As the adults are long-lived, it is possible that the heavy feeding and increase in numbers prior to winter prepares the insects for the period of relative inactivity that is seen during cooler months. It is possible that insects may also overwinter as eggs or pupae.

A variety of release strategies were used and this is in line with recommendations such as those by Shea and Possingham (2000) who state that, despite larger batch sizes being preferable, a number of different strategies should be employed due to the determinants of establishment being poorly known. Based on observations so far, some of our single release sites appear to have populations comparable in size to sites where multiple releases have been made. Further analysis will be carried out when mass releasing has concluded.

The observed increase in adult abundance and concomitant widespread feeding damage found in the field in autumn 2014, after a period of relative inactivity since surveys in the previous year, bodes well for establishment and potentially more damaging population levels. This may be a response to differing seasonal conditions or, conversely, the lack of insects in the previous season is simply due to the short period of time since release. Biological control insects can take long periods of time before establishment and damage occur (Mo *et al.* 2000). Interestingly, the adult feeding damage does not appear to be confined to young leaflets as mentioned in previous papers (Dhileepan *et al*. 2013), however these observations of insects were in captivity rather than in the field.

Jewel beetles displayed some degree of aggregation. This behaviour was repeatedly seen on the lower trunks of trees (<~1 m) of long-established sites and seemed to be more common on the warmer sunlit areas of the vines. This type of behaviour was not observed in the previous autumn and may be a result of populations building over time. Aggregation behaviour driven by pheromone attraction has been documented in many insects prior to winter for the purpose of mating (Bengtsson 2008).

Competition between this insect and the existing biocontrol agents is unlikely as they target different areas of the plant. For example, the tingid seems to be confined to leaves at ground level (Dhileepan *et al.* 2010), whereas the jewel beetle damage can be found up to 6 m from the ground. This distance may be an underestimate, as visibility becomes a problem further up the canopy. Once damage is very heavy, the extent may be more visible.

To help achieve a more rapid spread, this beetle has been supplied to various community and Landcare groups, councils and individuals in south-east Queensland for field release. Some groups have also begun their own rearing program. This will ensure distribution of the insect to a wider area. It is hoped that this insect will complement the tingid (*C. visenda*) and possibly the leaf-tying moth (*H. pyrochroma*) that were released in 2007. The tingid has become widespread and very damaging in some areas of south-east Queensland and New South Wales. Field surveys continue to try and identify areas of damage by the leaf-tying moth. It is expected that the field release and monitoring of the jewel beetle will continue for another three years.

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