

# Report

## On Visit to the Coringa – Herald Nature Reserve and SE Magdelaine Cay,

15-22 March, 2002

with regard to the releasing of parasitoids and ladybird predators  
of the pest scale *Pulvinaria urbicola* on *Pisonia grandis* and the  
assessment of biocontrol options for hawkmoths



Hawkmoth larvae on pisonia leaves.



*Cryptolaemus montrouzieri* larvae feeding on pulvinaria scale. Note the ants.



Aerial view of NE Herald showing hawkmoth defoliation of pisonia.



Pulvinaria scale parasitised by *Coccophagus ceroplastae*. Note the larvae and pupae inside the scales and the adult emergence holes.

Dan Smith and Dan Papacek

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## **ITINERARY**

NE Herald was visited on the Australian Customs Vessel Hervey Bay with Mark Hallam and team from 15 March 2002. Willis, SE Magdelaine and Coringa Cays were visited on 19-20 and SW Herald Cay on 21 March. All returned to Cairns on March 22.

## **OBJECTIVES**

- Assess the levels of scale and of the beetle *Cryptolaemus montrouzieri* on NE Herald, to clarify whether the beetle will persist at low scale host levels.
- Further assess the establishment of the parasitoids *Euryischomyia flavithorax* and *Metaphycus* sp. It was important to confirm their establishment throughout the island and their persistence in low scale numbers particularly if beetle numbers had so declined as to allow some scale resurgence.
- Determine if efforts to establish the high priority parasitoid *Coccophagus ceroplastae* in December were successful and to make further releases of *C. ceroplastae* if required.
- Reassess the situation on SW Herald particularly if regrowth had occurred with more rain. Release relevant biocontrols as required.
- Assess the situation and (if required and conditions allow) release *C. montrouzieri* on Coringa and SE Magdelaine.
- Investigate and report on biocontrol options for the hawkmoths on the forested cays.
- Provide a simple set of guidelines for the information of Environment Australia officers monitoring scale insect throughout the Coral Seas Reserves. This guideline (on a CD-Rom disk) is to include photographs showing the scale at various levels of infestation in the Coral Seas Reserves, and be sufficient to enable Environment Australia officers to make accurate, routine observations concerning scale insect population levels.

## **METHODS**

**Ladybird and parasitoid releases:** *Coccophagus ceroplastae* was again multiplied on *Pulvinaria urbicola* on young potted *Pisonia* plants at Nambour during December 2001 – March 2002.

These plants were grown in a sterile perlite/vermiculite mixture, trimmed back and then sprayed thoroughly with abamectin for mites and benomyl for leaf spots and further drenched with a mixture of ridomil and captan. Twenty plants were packed in an enclosed cardboard box for transport to Cairns and then taken out on the ACV Hervey Bay.

Approximately 5000 *Cryptolaemus montrouzieri* adults (from the Bugs to Bugs Insectary at Mundubbera) and 20 tubs of *Metaphycus* sp (total of about 2000 parasitoids) were also taken out.

The pisonia plants (with scale containing *C. ceroplastae*) were held on the ACV Hervey Bay until it was confirmed if this parasitoid had established on NE Herald after the December 2001 visit. As the parasitoid had established on NE Herald, the plants were taken on to Coringa where there were no pisonia surviving and planted in an area covering about 200 sq m on the central northern edge. *C. montrouzieri* (2000) and *Metaphycus* sp.(1500) were also released on pulvinaria scale on *Achyranthes* at Coringa and *C. montrouzieri* (2000) was released on SE Magdelaine and also on Willis (250). *Metaphycus* sp.(500) were released on SW Herald.

**Scale, ant and natural enemy assessments:** Scale/leaf samples were made on NE Herald (as described in Report No 1, 16-23 March 2001). Counts were made on this occasion (March 2002) every 60m. Scale samples were collected, examined using a binocular stereoscope on the island and stored in mesh tubs and tubes for further examination/rearing out on the mainland.

Hawkmoth infestation levels were also assessed on NE Herald by recording presence of the pest and damage on the sampled leaves – eggs (hatched or unhatched) larvae (instars 1-5), pupae (emerged or unemerged) and occasionally adult moths. Damage to the sampled leaves was rated 0- nil damage, (1) slight damage (<10% leaf damage) (2) up to 25%, (3) up to 50%, (4) up to 75%, (5) all of the leaf blade eaten.

## RESULTS

Counts from the transects on NE Herald made on 16-17 March are listed in Appendix 1 and the results are summarised in Table 1.

Transects 1, 3, 4, 7 and 11 had the highest scale levels with an average of 3.6, 2.7, 3.8, 2.7 and 2.8 scales per leaf respectively. The overall scale average per leaf was 2.1 and the average per cm of leaf was 0.16. This compares with 2.16 and 0.18 respectively for December 2001. These indexes had changed little but generally the scale infestation in March was more spread out than in December (42% versus 22% of sites infested). Transect 8 was the heaviest infested in December but one of the lowest in March. 95% of the scale was juvenile (1<sup>st</sup>, 2<sup>nd</sup> or immature adults) and only 5% were producing eggs. 85% of the infested leaves were from the low position in the tree as compares with 64% in December and 67% in August.

**Ant levels:** Total ant numbers were 361 *Tetramorium* sp. and 24 *Monomorium* sp. as compares with 238 and 3 for the same number of sites in December. Transect 3 had the most *Tetramorium* sp (107) and all *Monomorium* sp (24 were in transect 11). Ant numbers were slightly increased in comparison with December but half those in August 2001. All of the ants were associated with scale infested leaves usually low in the tree.

**Predatory ladybird levels:** *C. montrouzieri* was still heavily active throughout the island - wherever there were scale infestations. An average of 85% of scale infested leaves had live ladybird stages attending in comparison with 57% in December. There were relatively few egg-producing female scales recorded (total of 42 mature scales with eggs). In December there was a total of 1053 adult egg producing scales with 993 eaten out by the ladybird. In March there was a total of 607 egg producing scale and 565 eaten out. Of 317 live *C. montrouzieri*, 219 were larvae, 40 pupae and there were 58 adults on the sampled leaves.

**Predation by predatory moth larvae:** A total of 14 larvae of the predatory moth *Mataeomera* sp. were recorded. This predator which attacks a range of soft scales was not recorded previously on NE Herald and was not released. The larva eats the scale body and glues the scale covering into a tent-like protective covering which it carries around with it.

**Parasitism:** All three released parasitoids were in evidence with a total of 91 *Coccophagus ceroplastae*, 73 *Metaphycus* sp. and 41 *Euryischomyia flavithorax* confirmed. Parasitoids were present on 40% of all scale infested leaves and had spread successfully throughout the island since December when they were concentrated mainly in transects 8 and 10. Importantly, *C. ceroplastae* had successfully established following efforts in December. A precise level of parasitism was not

established but was estimated to be at least 10% of juvenile scale. Adults were commonly observed and parasitism of juvenile scale is likely to steadily increase up to over 75%.

**Hawkmoth levels:** The level of hawkmoth activity and damage in NE Herald was very high with 80% of the forest almost totally defoliated at time of sampling. The remaining patches, mainly on the southern end of transects 8 and 6 and on the northern end of transect 1, had heavy larval infestations and egg laying and there is little doubt that the whole forest would be defoliated before April. The overall rating result from the sampled leaves was 3.3 ie. there averaged over 50% destruction of the leaf blade. The worst transects were 1 (4.4) and 8 (3.9).

There had been heavy egg deposition, all stages of larvae were present and there were large numbers of pupae - some in curled up leaves (possibly *Hippotion velox*) and most of a second species (species A) in trash on the ground. The infestation had defoliated the trees beginning at the top and ending with the last small leaves near the ground. As the foliage was destroyed, there was ever increasing concentration of eggs and larva feeding on the very young remaining shoots low on the tree. Most of the larvae observed while sampling on 16-17 March are unlikely to complete their life cycle as earlier members of the generation had consumed nearly all available food. Late instar caterpillars littered the forest floor and even spread out over the beach rocks on the southern side of the island. In March 2002 there was about 50% leaf loss in transects 4, 6, 9 and 10 ie. about a third of the island was affected. At dusk hundreds of adult moths were attracted to the camp lights with at least two species species A and *H. velox* common.

### **S E Magdelaine**

SE Magdelaine had also been affected by the hawkmoth but the infestation was almost finished and appeared much less intense. In March 2001 about a third of the island was 75% defoliated but on this occasion the infestation had been much lighter (25%) and the forest was in good flush. **A single site infested with Pulvinaria scale** was recorded near the SE corner. About a dozen leaves on one twig had mainly juvenile scales and ants present.

*C. montrouzieri* adults (2000) were released.

### **Coringa**

The single small pisonia observed on the northern end in March 2001 was gone. Pulvinaria scale was moderately infesting the herbaceous plant *Achyranthes aspersa*. Releases were made of *C. montrouzieri* adults (2000) and of *Metaphycus* sp.(1000). The 20 pisonia plants (0.5 m high) were unloaded from the Hervey Bay and planted in two adjacent patches of about 10 x 10 m near the mid northern edge of the island. Their survival will depend on whether there is some wetting rain over the next few weeks at least. The herbaceous vegetation was light with some *Achyranthes* nearby infested with pulvinaria scale. The pisonia were infested with mostly second instar scale heavily parasitised with *Coccophagus ceroplastae*. It is likely that all 3 natural enemies of the scale will be established on Coringa.

### **Willis**

*C. montrouzieri* adults (250) were released on pulvinaria scale heavily infesting and destroying eggplants and capsicums in the island vegetable garden.

## **DISCUSSION**

**Scale and *C. montrouzieri* levels:** The 80% reduction in scale numbers from August 2001 has been maintained. Scale could be easily found on shoots on the lower parts of the trees, usually attended by ants but heavily infested (as in December) by *C. montrouzieri* and increasingly by the three parasitoids.

The heavy defoliation of the trees (progressively from the top down) would also cause a drop in scale numbers but may also have caused concentration of scale on the available remaining shoots low on the

trees. The hawkmoth defoliation has introduced unusual factors into the scale – natural enemy level and balance. Much of the scale occurs on the leaf blade near to the midrib and veins. However, by April most of the leaf (reduced to just sections of the midrib) will have dropped and the scale population will most likely reach very low levels and ladybird and parasitoid numbers will also drop to low levels. It is very likely, however, that scale will persist on green twigs and young new shoots and the natural enemies particularly the parasitoids will also persist.

Assuming there is average rain, the pisonia forest on NE Herald should vigorously re-leaf over the next few months.

**Parasitoid establishment:** All three parasitoids are now successfully established with adults and parasitised scale evident throughout the island. *C. ceroplastae* proved the most awkward to establish because the male appears to be hyperparasitic on the female. Female *C. ceroplastae* adults oviposit in scale as young as the early first instar producing female parasitoid larvae. By the second instar scale stage (after about 1-2 weeks) these parasitoid larvae are large enough themselves to receive a parasitoid egg which produces a male growing inside the female larvae. Ideally, to establish this parasitoid, a split release of adults is needed; the use of pisonia twigs infested with scale and the parasitoid at different stages in December obviously worked. On Coringa the use of actual plants (with scale and parasitoids) should also succeed in establishing *C. ceroplastae*. The low scale levels on NE Herald should not trouble the parasitoids and parasitism of juvenile scale could be expected soon to reach over 75%. (This could be established on any future visitations eg August or December 2002 by collecting a representative scale on leaf sample, placing in ventilated plastic food containers and returning to the authors on the mainland for assessing).

**SE Magdelaine:** The health of the pisonia forest and the modest level of hawkmoth damage was very pleasing but the discovery of one pocket of scale infestation was very significant. It is speculative to say how this infestation reached SE Magdelaine since our last visit in March 2001. *C. montrouzieri* was released but no parasitoids. Parasitoids should be released (particularly *C. ceroplastae*) sometime in the near future and much will depend on what the scale does over the next 12 months.

**SW Herald:** A thorough search of the herbaceous vegetation for pulvinaria scale particularly on the favoured host *Achyranthes aspersa* failed to locate any scale and there were no sightings also of *C. montrouzieri* so active in December 2001. It is hard to believe that there is no scale on the island but there has certainly been a dramatic drop. In December the scale was common and had killed numerous *Achyranthes* plants and scale infested plants were heavily infested by the ladybird. This may have been the cause of the dramatic decline in scale. There is also a possibility that *C. montrouzieri* has destroyed the whole population of pulvinaria scale on SW Herald. This would not normally occur in an area connected with the general environment as for example on the mainland.

**Coringa:** The scale was common on the *Achyranthes* on Coringa. Releases were made of *C. montrouzieri* and *Metaphycus* sp adults and *C. ceroplastae* was introduced on the 20 planted young pisonia trees.

**Hawkmoths:** The massive defoliation of the pisonia on NE Herald by the hawkmoths has put the forest under great pressure. If scale levels (as in August 2001) returned, the pressure would be much worse. Mark Hallam reports that a disturbing combination of the two pests occurred in the history of Coringa during the early 1990's – heavy defoliation followed by heavy scale infestation and then death of the forest.

The apparent complete absence of natural enemies – egg parasitoids, larval and pupal parasitoids and disease – viruses, bacteria and fungi is very unnatural, allowing massive population increases - unsustainable to the pisonia forest. Some defoliation is acceptable but not total leaf loss. The species almost certainly occur on the mainland and (as all Lepidoptera) have parasitoids and pathogens that usually keep them at modest and unspectacular levels. Introduction of biocontrol agents will not threaten survival of the hawkmoths (or of other Lepidoptera) but should prevent massive outbreaks.

Identification of the species of hawkmoth is still being verified. One species (the 2<sup>nd</sup> most common) is *Hippotion velax* (Fab.). It occurs throughout the Western Pacific with plant hosts including the vine

*Pisonia aculeate*, the bird-lime tree *Pisonia umbellifera*, *Alocasia indica* and sweet potato *Ipomoea batatis* (Common 1990). Larvae spin 2-3 leaves together to hold the pupa. The hawkmoth larvae were predominantly green with some brown forms. The 1<sup>st</sup> abdominal segmental eyespot is large and prominent.

On the mainland, hawkmoth species are parasitised by small trichogramma wasps (in the eggs), and by Tachinid flies and Pteromalid and Ichneumonid wasps in the larvae. Pathogens – nuclear polyhedrosis and granulosis viruses, bacterial and fungal infections also are common, particularly when these are large numbers of larvae. During this visit in March 2002, releases were made of *Trichogramma pretiosum* and some *Trichogramma carverae* (mass reared in the “Bugs for Bugs Insectary”) mostly on NE Herald (18000) on some also on SE Magdeleine (2000). Fresh hawkmoth eggs collected from NE Herald and exposed to the Trichogramma, produced up to a dozen tiny wasps emerging from a single egg.

The scale-natural enemy relationship on NE Herald is very promising for the short and long term. The following questions remain unresolved - will the forest recover; will there be lasting detrimental effect; will a low level of hawkmoth infestation occur over the next few months; will a similar heavy infestation occur next summer; will the *Trichogramma* released have a lasting impact; what subsequently happens with the scale infestation and the natural enemies?

## RECOMMENDATIONS

The recovery of the forest can be observed by aerial photography and

- **Monthly aerial photos are recommended** of NE Herald and SE Magdeleine from April until the next visit by Environment Australia staff. These should help in confirming the recovery of the forest. They should be useful (once the forest has recovered) in detecting future leaf drop from succeeding hawkmoth infestations. Effects of scale may also be detected but these would have to be severe and well advanced to show on the aerial photos. The progress or otherwise of the young new trees on Coringa may also be detectable on aerial photos.
- Environment Australia staff (or other researchers) visiting the cays need to record the **health of the pisonia forests with regard to Pulvinaria scale, and hawkmoth infestations**. The ‘*Guidelines for monitoring*’ (see attachment) details a simple monitoring system for these pests.

**(1)- Important scale data** to collect would be a scale level index like scale average/cm of leaf or % of actively infested leaves looking at the same number of transects used in August 2001 (2, 4, 6, 8) at 60m intervals. Parasitism levels in the scale could be established (on any future visitations eg August or December 2002) by collecting a representative scale on leaf sample, placing in ventilated plastic food containers and returning to the authors on the mainland for assessing.

**(2)- Important beneficial data** would be- the % of scale- infested leaves with evidence of ladybird and the % of scale- infested leaves with evidence of parasitoids.

**(3)-** On these sampled leaves a rating could be done on **hawkmoth damage** and a count made of live moth stages – eggs, larvae and pupae. A collection of unhatched hawkmoth eggs would allow an assessment to be made of egg parasitism. Eggs could be held in small plastic tubes to check for parasitoid development and emergence. Alternatively a series of single eggs could be inserted into a special small sheet with indents; the eggs in the sheet are then covered with gladwrap.

- At the very least, a judgement should be made on the health of the pisonia forest, whether scale (and ants) are serious, whether active ladybirds and parasitoids can be seen and whether serious hawkmoth activity is building up or has recently been active.

- **On SE Magdeleine** the progress of the scale and ladybird populations should be recorded. The parasitoids, especially *Coccophagus ceroplastae* should be released if the scale increases. It is possible if *C. montrouzieri* (released in March) establishes, that the scale will be reduced to very

low levels. The experience of SW Herald suggests the possibility of the ladybird totally destroying such a light infestation.

- On SW Herald and Coringa the progress of scale and natural enemies will continue to be of interest.
- Environment Australia staff visiting the Coringa – NE Herald Reserve should take out 500-1000 *C. montrouzieri* adults on each occasion as a back up release/reestablishment option (necessary or not).

Ladybirds and parasitoids could also be moved between islands eg from NE Herald to SE Magdelaine if warranted but sourcing insectary reared material from the mainland is probably the best option.

- It will be difficult to assess the **impact of the *Trichogramma* releases** on future hawkmoth infestations without periodic visitation. The parasitoids presence or absence can be confirmed if unhatched eggs are collected and held in a tube and returned to the authors.

Serious consideration should be given to **releasing 1 or 2 larval parasitoids of the hawkmoth and testing *Bacillus thuringiensis*** and nuclear polyhedrosis or granulosis viruses. The authors intend to follow up by establishing what natural enemies there are (of the relevant species) on the mainland.

If future hawkmoth infestations are more restrained and there is evidence of good egg parasitism, further action may not be necessary.

*Trichogramma* may also require a yearly release-for example in mid summer. If it is established that *Trichogramma* releases are a good strategy for containing the hawkmoth this could be done on a December or January visit by Environment Australia staff. All that is required is for 6-12 sheets (1000 parasitised host eggs per sheet) to be hung in the pisonia on each island. If aerial photos suggest serious infestations are developing and visitation is not feasible and *Trichogramma* releasing is shown to be a viable strategy, aerial drops of beneficials might be an option. It may be feasible to drop a suitable canister of egg sheets from a safe elevation (with reference to the seabirds) from a surveillance plane. The same applies for parcels of adult *C. montrouzieri*.

- As recommended in December 2001 there is a need to:
  1. **prepare press and TV release material** (Mark Hallam assisted by D Smith) to strongly publicise the success in saving the *Pisonia* forest on NE Herald.
  2. **begin preparation of a scientific publication** (D Smith assisted by M Hallam and D Papacek);

#### **Future visits to assess scale/beneficial levels in particular**

- A yearly December/January visit (combined with turtle/bird studies) is the best timing (on a once a year basis) to assess scale, hawkmoth and beneficials in the future. Insect populations can easily resurge and it is vital to maintain a basic level of monitoring on the very important Pisonia forests on NE Herald and SE Magdelaine and on other infested vegetation on Coringa and SW Herald. Basic monitoring can be done by Environment Australia staff visiting in December or at other times in the year (eg in August). December-January appears to be the main time of the year when the hawkmoth begins to build up. December-January, August or March-April are good times for any future specialist entomology consultancy.

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