USA Northampton, Massachusetts. *Biological Control for Nature*
3-7 October 2010.

Measuring interactions of introduced parasitoids and scale insects in a natural ecosystem

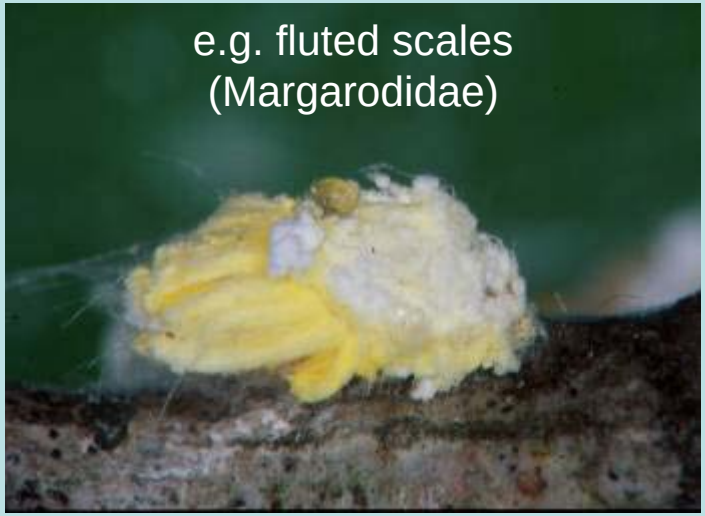
Pink wax, *Ceroplastes rubens* + other Coccidae

▶

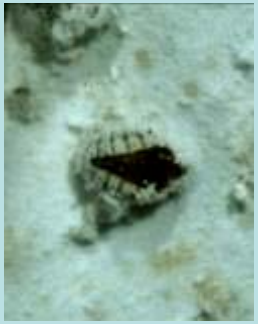
infesting rainforest tree *Pittosporum rhombifolium* in Queensland

CSIRO

All biological control programs need taxonomic inputs for target and natural enemy identifications



Icerya purchasi



Icerya seychellarum

Each predatory *Rodolia* spp. may have different (margarodid) host preferences

Males scales may be rare or difficult to identify

CRITERIA FOR ASSESSMENT OF ECOSYSTEMS WITH SCALES: PRE- AND POST-RELEASE OF AGENTS

- What species of plants are hosts for the target scale. Are other scales present ?
- How heavy are the infestations (i) of target scales and (ii) sooty mould on each plant species?
- What ant species are attending scales and feeding on honey dew and how numerous ?
- What natural enemies of the scales are already present and how abundant before agents are released ?
- Do natural enemies appear similar and similarly abundant on each infested plant ?

Some scale secretions coalesce – difficult to assess numbers & natural enemies

Fluted scale
Icerya aegyptiaca
in Micronesia

Can individual scales & natural enemies be examined and counted ? ↓

Unidentified native plant

palm

Cryptochaetum sp.
parasitoid

Methods for pre- and post- monitoring *Ceroplastes* spp. in indigenous plant communities

- Monitoring infested plants in forests and woodlands.
- Infested and un-infested plants mapped using transects of appropriate length (e.g. 50 m) and width (e.g. 30 m)
- Frequency of sampling / observations (e.g 1/3 months) based on seasonal cycles of reproduction
- Each infested plant: (i) identified, (ii) height or basal diameter recorded and (iii) rated for (a) no infestation or (b) infested (estimated % of stems covered / numbers on infested leaves)
- Sooty mould rated for each infested tree

Establishing & monitoring introduced natural enemies

Establishing
Anicetus beneficus
on Norfolk Island - an
agent for *Ceroplastes rubens*

Tagged stems to monitor
Ceroplastes destructor
and *C. rubens*

Scales: visual, non-destructive scale counts and assessments

For each tagged & identified tree recorded:

- **scale numbers and densities on leaves & stems**
- **presence of natural enemies, damage or emergence holes**
- **% leaves covered with sooty mould**
- **ant identification (exotic / indigenous) and their abundance**
- **Identify & monitor pre-release/indigenous natural enemies**

Ceroplastes rubens + sooty mould

A method for destructive sampling of scales for monitoring, counts and ratings

Infested stems

- cut (e.g. 3 x 30 cm) & returned to lab. for 100-scale processing

- (i) stems/leaves placed in emergence units for natural enemy emergence

- (ii) scales set aside for dissection - before and after wax removal

Processing of scales for parasitoids

- Stems (> 30 + scales) collected from each infested tree, cut & returned to lab.

- Stems examined for scale damage / parasitoid holes & predators before removal of wax coating
  (wax dissolved with warmed xylene-alcohol mix, or removed mechanically)

- De-waxed scales brushed from stems and leaves, transferred to 70% alcohol in petri dish

- 100 scales (of each instar) examined and processed microscopically for parasitoid stages

Post release of parasitoids – processing 100 scales per sample -

Process crawlers & 1st instars separately from 100 scales

- Note instars of larvae and estimate as “live” or “dead” numbers of females (before de-waxing)
- * check identity of each scale, search and record males (rare for most *Ceroplastes*)
- note if scales “healthy” and with abnormalities, scars or stages of internal or external parasitoids (identify when possible)

C. rubens on rainforest leaf

BIOLOGICAL CONTROL OF WHITE WAX SCALE IN CROPS PREVIOUSLY AFFECTED

Ceroplastes destructor:

Transect monitoring and sampling demonstrated –

- Biological control was achieved in citrus plantations within 5 years of release of African parasitoids, *Anicetus communis* and *A. nyasicus*
- Control of scale resulted in extreme rarity in all crops previously affected.
- Rate of control in crops varied with parasitoid species, latitude and host plant species (slower on some plant species)

BIOLOGICAL CONTROL OF WHITE WAX SCALE IN ECOSYSTEMS

Modified methods demonstrated –

- Parasitoids spread rapidly in rainforest and open woodland plants
- Decline in scale abundance and sooty mould was followed by rapid responses in the indigenous plant hosts within 2 years
- Exotic ants declined in abundance in most ecosystems but maintained their presence in the two rainforest and woodland ecosystems monitored

BIOLOGICAL CONTROL OF WHITE WAX SCALE, *Ceroplastes destructor*

In crops and natural plant communities, methods demonstrated –

- A decline in scale density and overall abundance on stems (1969-1972) correlated closely with % parasitisation by two introduced African parasitoids, *Anicetus communis* and *A. nyasicus*

- Each parasitoid differed in preference for the stage of female scales attacked (mature nymphs vrs adults respectively):

  - larvae of *A. communis* entered diapause (in autumn), coinciding with protracted development of uni-voltine scale development: effective agent in temperate climates

  - larvae of *A. nyasicus* show protracted development in cooler months, without diapause in bi-voltine scales; an effective agent in sub-tropical and tropical climates

  - a narrow subtropical range where both parasitoids overlaped and contributed to control

BIOLOGICAL CONTROL OF PINK WAX SCALE

Ceroplastes rubens:

- Control in citrus orchards within 3 years of release of the Japanese parasitoid, *Anicetus beneficus*
- Partial control slowly extended to indigenous rainforest plants monitored
- The rate of control varied with the scale's host plant and its exposure to light
- Scale abundance and sooty mould leaf cover on indigenous plants did not always relate to % parasitism of scales